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A BOAT VOYAGE THROUGH THE GRAND CANYON OF THE COLORADO

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Geographical explorations in the United States have had no more interesting field than the Grand Canyon of the Colorado. The Grand Canyon was discovered in 1540 by one of the Spanish *conquistadores*, Don Lopez de Cárdenas, a captain in Coronado's expedition, in the quest for the fabled gold of the Seven Cities of Cibola; but almost nothing of its true nature was learned until barely fifty years ago. Now at last the mighty torrent which has carved this mile-deep chasm has been accurately surveyed, all the details of meander and profile have been charted, and new maps are being prepared which will portray in correct detail many geographic features heretofore unknown or in doubt.

HISTORY OF EXPLORATION

The canyon was first really explored in 1869, by Major John Wesley Powell, who started downstream from Green River, Wyo., to go through the thousand-mile stretch of canyons of the Green and the Colorado and discover their long-hidden secrets. With eleven men he embarked in four small boats, and after three months of hardship and disaster, in which instruments were lost, boats were wrecked, and three of his men deserted him, he succeeded in reaching the mouth of Virgin River. The achievements of all subsequent explorers of the river seem small or insignificant when we remember that Powell knew almost nothing of the rapids or falls that lay before him. His party made a reconnaissance survey of the river, but, as many of the notes were lost, he decided to make another trip. His second expedition left Green River, Wyo., in May, 1871, and, fortified by its previous experience, proceeded down the river more easily and made

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FIG. 1—Looking down Marble Canyon from a point 37 miles below Lees Ferry. (Photograph by E. C. La Rue.)

more complete observations but was stopped at the mouth of Kanab Creek by high water. Powell later became the second Director of the Geological Survey, and his early explorations have always been an incentive to members of that organization to complete the surveys he thus began.

While the Powell party was making its second voyage through the upper canyons, Lieut. George M. Wheeler, accompanied by G. K. Gilbert, geologist, and a large party, was battling his way upstream through the lower end of Grand Canyon. Although Powell had descended this part of the canyon two years before, he had been compelled to travel with the utmost speed and had scant time for observation. The work of the Wheeler expedition therefore added much to our information. The party met appalling obstacles and succeeded in reaching their objective, the mouth of Diamond Creek, only by almost superhuman effort in the face of starvation.

In order to determine the feasibility of constructing a railroad through the region an expedition was organized in 1889 by Frank M. Brown. This expedition encountered tremendous difficulties, mainly because the boats were not fit for navigating rough water, and was abandoned when Brown and two other members of the party were drowned in the upper part of Marble Canyon. Undaunted by these mishaps Robert Brewster Stanton, the chief engineer of the Brown party, at once organized a new expedition, which successfully

traversed the waters of Marble and Grand canyons and continued to the Gulf of California.

In 1896 Nathan Galloway, a Utah trapper, with one companion, made the complete voyage through the canyons from Wyoming to Needles. Galloway designed the type of boat which has since been used almost exclusively in the canyons of the Colorado, and later parties have profited much by his careful study of the features and conditions of the river. During the same year George Flavell and one companion traversed the Colorado from Green River, Wyo., to Yuma, Ariz. Little is known about this expedition except that one flat-bottomed boat was used and that the trip consumed four months. In 1907 Charles Russell and E. R. Monett journeyed from Green River, Utah, through Cataract, Marble, and Grand canyons, using steel boats somewhat similar to Galloway's wooden boats. They lost one boat at the upper end of the Grand Canyon but completed the voyage in the other. In 1909 Julius Stone, accompanied by Galloway and three other companions, made the voyage through the canyons. Galloway's experience in 1896 proved invaluable, and the party made the trip with less difficulty than had been encountered during any other voyage down the canyon, both Stone and Galloway taking their own boats through without an upset or serious accident. In 1911 Emery and Ellsworth Kolb, scenic photographers of the Grand Canyon, made an adventurous and successful voyage from Wyoming to the Gulf of California.

FIG. 2—Looking down canyon of Kanab Creek from a point one mile above its mouth. (Photograph by E. C. La Rue.)

After 1911 no successful attempt was made to navigate the waters of the Grand Canyon until the summer of 1923. For a number of years the Geological Survey had been making surveys along the Colorado and its tributaries, mainly with a view to controlling and properly utilizing the wasting waters. Surveys had been made along all of the river except the stretch through the Grand Canyon, and it was to fill in this gap that the expedition here described was organized. The Survey expedition had the benefit of the experiences of other expeditions as well as much more accurate knowledge of the country to be traversed than had been available to earlier explorers. The credit for the successful navigation of this stretch of the river, which includes some of the roughest water in the United States, must go to the boatmen of the party, who had had experience on the Colorado and were charged with the responsibility of getting the boats through the rapids. Their success made possible the engineering work and scientific studies undertaken by the party.[1]

The Start at Lees Ferry

Leaving Flagstaff, Ariz., on July 18, with loads of equipment, food supplies, and one new boat, we started for Lees Ferry, 140 miles to the north, where the three old boats that were to be used had been stored. These required complete, careful overhauling before they could be started on the long journey downstream. The scene of our two weeks' final preparation for the canyon journey, Lees Ferry, is a place of unusual geologic and geographic interest. It is the only place for hundreds of miles up or down stream where the Colorado River can be approached without a descent into a forbidding canyon. Here the massive, thick sandstone that stretches almost interminably eastward through the country in which Glen Canyon is carved takes a sharp upward bend that forms the great wall known as Echo Cliffs and brings to the surface west of the cliffs a great thickness of soft shales that are readily worn down by erosion. Along the passageway afforded by these worn-down soft beds Mormon immigrants from southern Utah early found a way into the Arizona country south of the river, and today the only road follows the same route. From beneath the soft beds there appears to the southwest the top of the resistant Kaibab limestone, which, rising gradually but steadily, forms the capping of the plateau into which the Marble Canyon of Colorado River has been incised (Fig. 4).

At last we were ready for the start. Our little navy consisted of four wooden boats of the Galloway type, 18½ feet long by 4½ feet beam, decked over fore and aft and fitted with water-tight hatches and airtight com-

[1] The party consisted of ten men, the scientific members being: C. H. Birdseye, chief topographic engineer of the Geological Survey, director of the party; E. C. La Rue, who for several years has been studying the problem of utilizing the waters of the Colorado River, hydraulic engineer; Raymond C. Moore, who for some time has been engaged in geologic work in Utah and Arizona, geologist. R. W. Burchard, topographic engineer, who had already surveyed the lower stretches of the river, did most of the mapping work; Emery C. Kolb was head boatman; and the party also included Lewis R. Freeman, whose book "The Colorado River" is reviewed elsewhere in this number of the *Review*.

partments. The oarsmen sat in an open cockpit in the center, running the rapids stern first, so as to have as much chance as possible to avoid the rocks and rough waves. A strong, light canvas boat was provided to aid in the work of the rodman. All the men wore life jackets, and in rough water the passengers lay face down on the decks, clinging to life lines strung along the gunwales. Light sleeping bags, air mattresses, and other equipment, including personal dunnage, which was kept to the absolute mini-

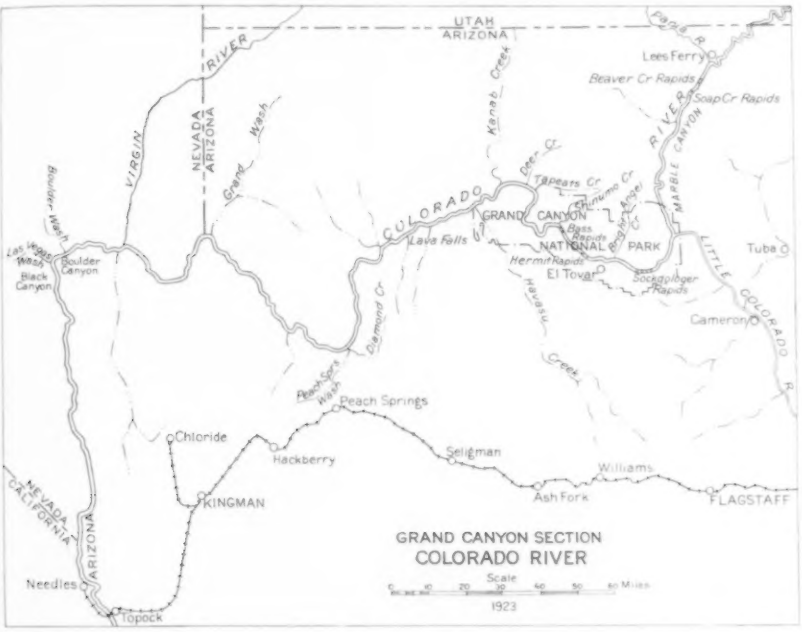


FIG. 3.—Outline map of the Grand Canyon section of the Colorado River. Scale approximately 1:3,000,000.

mum, were packed in water-tight bags or boxes. An assortment of cameras, including two motion-picture machines, and a plentiful supply of film packed in water-tight boxes were carried. A radio receiving set had been provided and worked exceedingly well, in spite of predictions that radio communication in a deep canyon was impossible.

MARBLE CANYON

The beginning of Marble Canyon is a boxlike gorge having nearly vertical side walls rising from the river's edge. In less than four miles from the point at the mouth of Paria River where the limestone of the canyon walls first appears the hard Kaibab limestone and Coconino sandstone, which form the rim throughout Marble and Grand canyons, are exposed in their full thickness, about 550 feet, above the water, and a soft forma-

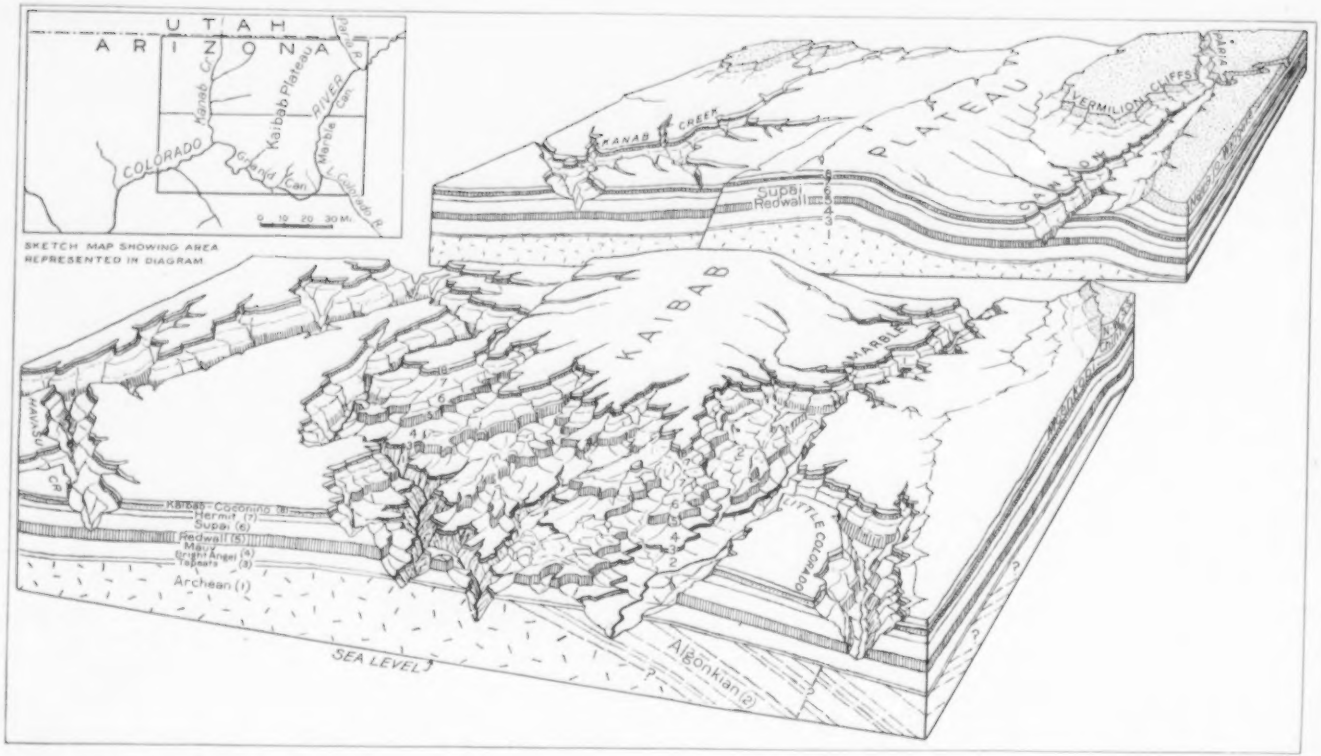


FIG. 4—Block diagram showing how the topographic features of Marble and Grand canyons are controlled by the character of the rock formations. (In the series of formation names for Mauv read Muav.)

tion, the Hermit shale, appears below. Accordingly, a slope has been formed on both sides of the river at the bottom of the canyon, and as more of the soft beds appear the height of the slope and the width of the canyon increase.

Toward the close of our first day in the canyon we reached Badger Creek rapids, the first in Marble Canyon, seven miles below Lees Ferry. These rapids have a fall of 13 feet in about 100 yards, and to us who were just beginning our trip the water looked forbiddingly rough and wild, but our experiences farther downstream made it seem in memory rather unappalling. Even in these rapids, however, the first boat struck a rock with such force that a hole was knocked in its bottom.

Soap Creek rapids, three miles below, is an exceedingly bad stretch of water, which has never been run safely by any party. We portaged the boats past the head of the rapids, carrying and skidding them for about 25 yards over the rocks to an eddy below. Perhaps we might have gone through safely without portage, as we ran worse rapids later, but it did not seem wise to take the chance so early in the trip.

A short distance below Soap Creek we found a massive, hard sandstone, the Supai formation, which appeared beneath the soft red slope-forming shale, and as the cliffs of sandstone increased in height the slope and cliffs above were lifted higher and higher above the river. At 23 miles below the Paria the rugged sandstone walls are more than 800 feet high, and the overlying slopes and cliffs add 1300 feet more to the depth of the canyon. Here the top of the greatest cliffmaker of the Grand Canyon, the Redwall limestone, appears, and farther downstream a magnificent, vertical-walled inner gorge is carved in this rock. It is this gorge, with its long stretch of swift-running water between high, smoothly polished walls of limestone, that has given to Marble Canyon its name.

Rapids after rapids followed in quick succession through Marble Canyon, at several of which the sheer walls of the canyon made portage or climbing around impossible, so that all passengers had to ride through. The traverse and level survey line was, however, carried through the canyon without a break, and many detailed surveys were made at points where construction of dams seemed feasible.

The canvas boat was lost in the thirteenth rapids in an attempt to "line" it around. The canoe might have been portaged, but as the shore was piled with enormous boulders the portage of even this light boat would have been difficult. The only other accident in the 60 miles of Marble Canyon occurred in Boulder rapids, 43 miles below Lees Ferry. A mass of rock that had recently tumbled into the center of the channel, as indicated by the scar on the canyon wall opposite and by the absence of records concerning it by previous travelers, caused the waters to divide in tremendous waves and to form a dangerous maelstrom in its lee, and here one member of the party was thrown out of his boat but recovered it without assistance.

The bottom of Marble Canyon in its lower part is composed of relatively weak beds—the Muav limestone and Bright Angel shale, which, as might be expected, form slopes. For several miles above and below the mouth of the Little Colorado the hard basal Cambrian Tapeats sandstone crops out along the river, forming cliffs that attain a height of 250 feet.

On August 13 the party reached the mouth of the Little Colorado, which poured into the main stream a flood of yellow water that was dirtier

FIG. 5—The boat *Boulder* being portaged over the rocks at the head of Soap Creek rapids. These rapids have never been run safely by any boat party. (Photograph by E. C. La Rue.)

even than that of the Colorado. This point marks the end of what is commonly called Marble Canyon and the beginning of Grand Canyon, but the whole stretch of the river through the plateau, from the Paria River downstream to the Grand Wash Cliffs, might well be called the Grand Canyon. Twenty-two rapids were encountered in Marble Canyon, and all except Soap Creek rapids were run without portage. The distance from Lees Ferry by river to the Little Colorado is 60.5 miles, and the fall is 400 feet.

ENTERING GRAND CANYON

Only a little way below the mouth of the Little Colorado soft rocks belonging to the ancient Algonkian series begin to appear beneath the cliff of Tapeats sandstone. Four miles from the Little Colorado a great fault trending northwest elevates the rocks on the downstream side some thousands of feet and brings a great thickness of the Algonkian sediments to the surface. As these rocks are mainly rather soft the canyon here loses at once its closed-in form, the confining rims appear to recede, the lower part of the canyon is broad and open, slopes are less abrupt, and

the river, notably increased in width, winds about in leisurely fashion though still swift and not lacking in rapids.

At a point 17 miles below the Little Colorado we entered the Upper Granite Gorge, a very narrow, rugged, steep-walled, deep canyon within the Grand Canyon. The change in the character of the bottom part of the canyon is patently due to the difference in the nature of the rocks in which it is carved. These are hard, massive crystalline rocks, mostly schist and gneiss. The distinctive topography that is developed in these

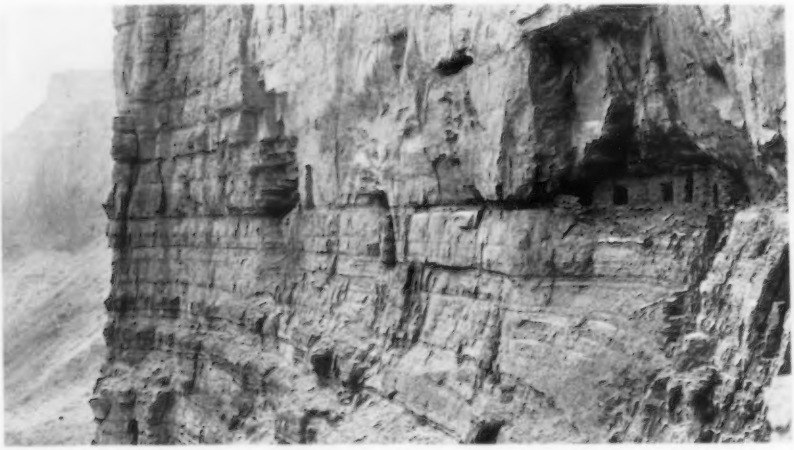


FIG. 6—Cliff dwellings in the right hand wall of Marble Canyon near mouth of Nankoweap Creek. Dwellings about 600 feet above river. (Photograph by E. C. La Rue.)

rocks continues downstream as far as the river encounters this sort of rock, and it reappears in each place where crystalline rocks rise above the river.

UPPER GRANITE GORGE AND SOCKDOLOGER RAPID

The worst rapids on the river, according to report, are in the Upper Granite Gorge. One of these is known as the Sockdologer rapid, so named by Major Powell as representing the largest of all. The height of the fall at this point has been immensely exaggerated in some accounts of trips through the canyon, one recording a drop of 80 feet in a third of a mile. The fall really amounts to only 19 feet, but most of it occurs in the first 100 yards. It is impossible to climb around this rapid, and so all had to ride the boats. Seen from above the rapid, the first boat and its passengers were glimpsed only at intervals. The boat was out of sight most of the time, but finally appeared below right side up, and one by one the other boats successfully made the descent. Several other large rapids occur in the Upper Granite Gorge, but all were run without difficulty other than the usual bath of dirty water. We reached the mouth

FIG. 7

FIG. 8

FIG. 7—Junction of the Colorado and Little Colorado Rivers—the Colorado in the middle background. (Photograph by E. C. La Rue.)
FIG. 8—Looking down the Upper Granite Gorge from mouth of Mineral Canyon. (Photograph by E. C. La Rue.)

FIG. 8—Looking down the Upper Granite Gorge from mouth of Mineral Canyon. (Photograph by E. C. La Rue.)

FIG. 9

FIG. 10

FIG. 9—The big bend in the Colorado River 65 miles below Bright Angel Creek. (Photograph by E. C. La Rue.)
FIG. 10—Downstream view of Grand Canyon from a point 50 miles below Havasu Creek. (Photograph by E. C. La Rue.)

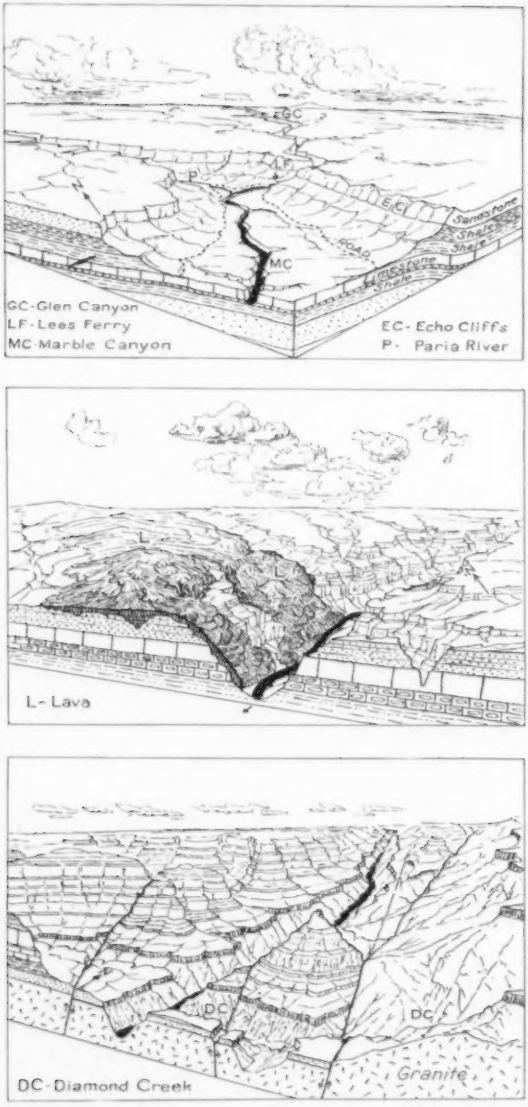


FIG. 11—Block diagrams of Colorado canyons.

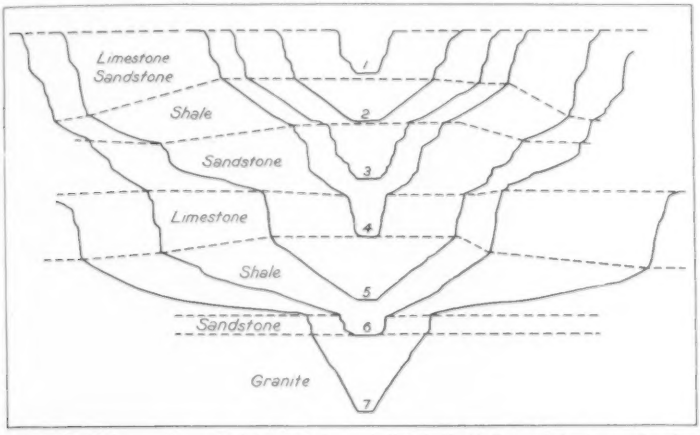
The uppermost figure shows erosion of soft strata between Glen and Marble canyons.

The middle figure shows invasion of Grand Canyon by lavas from the plateau above, near the Toroweap fault.

The lowest figure shows faulted area near Diamond Creek. The river does not follow the faults.

of Bright Angel Creek on August 23, passing under the frail-looking suspension bridge which affords the only good means of crossing in the whole Grand Canyon area. At this point we climbed to the south rim and spent three days "in civilization."

The voyage was resumed on August 27, when the boats plunged at once into a series of bad rapids below Bright Angel Creek. At Bass Canyon rapids we passed under a cable ferry 300 feet long and 50 feet above water. The cable affords a fair crossing of the river at this point, and with a man



1. Upper Marble Canyon, three miles below Paria R
2. Upper Marble Canyon, at mouth of Soap Creek
3. Upper Marble Canyon, twenty miles below Paria R
4. Middle Marble Canyon, below Vaseys Paradise
5. Lower Marble Canyon, at mouth of Kwagunt Cr
6. Three miles below mouth of Little Colorado R
7. Granite Gorge above Bright Angel Creek.

FIG. 12—Profiles of Marble and Grand canyons showing the manner in which the topography and the width of the canyons are controlled by the character of the rocks.

on top of the car to operate the windlass, a horse can be carried across, if he is a tractable animal.

As has been well described by Noble[2], the crystalline walls of the inner gorge descend almost to the river in the vicinity of Bass and Shinumo creeks, where there is a considerable area of soft Algonkian rocks, in large part similar to those found above the Upper Granite Gorge. In consequence, the lower part of the canyon is more open. Not far below, however, the granite gorge resumes its typical character, which continues to the great south bend of the river around Powell Plateau. Except for a few short intervals the bottom of the canyon in Stephen and Conquistador aisles, west of Powell Plateau, consists of the lower Cambrian sediments, which produce a cross section of the canyon very similar to the lower part of Marble Canyon.

[2] L. F. Noble: The Shinumo Quadrangle, Grand Canyon District, Ariz., *U. S. Geol. Survey, Bull. 549*, Washington, D. C., 1914.

Lower Granite Gorge

A second narrow deep gorge in crystalline rocks, the so-called Lower Granite Gorge, much shorter than but otherwise similar to the first, was passed by the party. At its lower end was found another area of Algonkian strata, less extensive than those seen before.

The party ran rapid after rapid without serious difficulty until the morning of September 8, when a particularly bad rapid with a fall of 15 feet was reached at a point 70 miles below the Little Colorado. No party had yet run this rapid; but the boatmen, after carefully looking it over and testing the current by throwing into it bits of driftwood, decided that it could be run safely. Three boats went through without misadventure, but one struck a rock near the lower end of the rapid and on pulling out below was found to have suffered a bad smash in the stern. Repairs with white lead, canvas, and copper sheeting put the boat in as good shape as before.

Delaying a day at the mouth of Tapeats Creek, 72 miles below the Little Colorado, we ascended this interesting side canyon, observing the magnificent series of waterfalls, 800 or 900 feet in total height, where the nearly ice-cold water of the creek springs from the limestone cliff, and finding some old Indian ruins.

Fishtail Canyon and Kanab Creek

We reached Fishtail Canyon at noon on September 10 and saw the eclipse of the sun, which was here about 75 per cent total. It was at no time too dark to prevent work on the survey line; but in the dim light the shadows became blurred and fuzzy, and the whole canyon took on a gloomy and desolate aspect. This part of the canyon is floored by the Cambrian beds, and the bottom is accordingly not narrowly inclosed. An interesting feature, well shown on the topographic map of the Supai quadrangle, was observed just above the mouth of Fishtail Canyon. A very prominent alignment of tributary canyons trending northeast or southwest was found to follow a displacement in the rock strata, which is surprisingly small—only 23 feet where measured at the river. That night we camped at the mouth of Kanab Creek, which comes in from the north. This is the point where Major Powell abandoned his second expedition in 1871 and where he and his associates traveled up the creek to the north rim. We had hoped to find a good flow of clean, clear water here but found the stream nearly dry, and the little water that was flowing was slightly brackish.

Just below Kanab Creek, where the rock strata drop slightly faster than the fall of the river, massive limestones are brought to the water's edge, and great, nearly sheer cliffs rise 1600 feet on each side, with benches up to 2500 feet higher farther back. This is the deepest narrowly inclosed gorge that was found in the journey through the canyon. It extends essentially

without change to a point nine miles below Havasu Creek, where the soft rocks reappear in the bottom of the canyon and the walls accordingly begin to widen.

Six miles below Kanab Creek we came upon an exceedingly bad rapid, around which most of the cargo of the boats was portaged. There are

FIG. 13

FIG. 14

FIGS. 13 and 14—The topographers at work. The precipitous walls often made selection of instrument stations difficult. Figure 13 is in Marble Canyon. (Photograph by E. C. Kolb.) Figure 14 is in a side canyon 10 miles below Havasu Creek. (Photograph by E. C. La Rue.)

two big rocks in the channel near the foot of the rapids, and below each of these is a very large hole or whirlpool. Kolb, the chief boatman, ran the first boat through as usual and was drawn into one of these whirls. He was finally able to work his way out and his boat was caught at the foot of the rapid. The rest profited by his experience and maneuvered the other boats through the rapids safely.

LAVA FALLS

On September 13 we reached the mouth of Havasu Creek, at the west edge of Grand Canyon National Park. Here the packers had been waiting

for three days with mail and supplies. A little-used trail down from the Havasupai Indian Reservation follows the narrow, precipitous gorge of Havasu Creek and in places goes through tunnels that have been constructed to get by the falls. Nineteen Supai Indians were used to pack in the supplies, and, though the reservation is less than 10 miles from the river, none of these Indians had ever before made the trip down the steep, narrow gorge. Below Havasu the boats were run through numerous rapids with little difficulty. At 21 miles below Havasu Creek we passed a large lava pinnacle, which partly obstructs the channel but, curiously enough, forms no rapids. This is evidently the remains of a volcanic barrier, the rest of which has been eroded away by the action of the water. It is an unmistakable landmark, and voyagers by water should take warning of a very dangerous rapid, Lava Falls, a mile and a half below. The rapid is at the mouth of a canyon that comes in from the south, along the line of the Toroweap Fault, which here crosses the river, and is formed by great flows of basaltic lava from the volcanic outlets on the plateaus above. At one time the lava filled the lower part of the canyon, damming the river temporarily to a height of several hundred feet. Although the drop of Lava Falls is only ten feet, so many dangerous rocks here extend across the river that no one has attempted to run through. Portage on the left bank was easy and was accomplished largely by lining, so that the boats were seldom taken completely out of the water.

We camped at this point and at dark noticed that the river had suddenly begun to rise. The boats were moored in a rather insecure place just below the rapids and were soon pounding badly in the waves. Kolb thought he remembered a shelving beach a quarter of a mile below, and evidence of his good judgment was renewed when an excellent mooring was found just where he expected it. The river continued to rise at the rate of about 18 inches an hour and reached the peak of 21 feet the following afternoon. No one had expected such a rise, and we were up all night pulling one boat or another to a higher place on the bank. The rapid, which had been a very short, sharp-crested fall before the flood, now stretched downstream as far as the eye could see, a tumble of racing water, some of the big waves running fully 20 feet high and throwing spray much higher. Immense quantities of driftwood, including many large logs, were carried downstream. Later we learned that the volume of the river had jumped from 10,000 to 125,000 second-feet during the flood.

The river subsided slowly, and we waited four days before we could launch the boats. Proceeding downstream, we found that the invasions of lava into the canyon continued here and there for about 10 miles. We could glimpse the borders of the great lava masses and an occasional volcanic cone on the plateau above. We found clinging to the sides of the canyon near its bottom numerous flat-topped remnants of lava flows which had run many miles from the point of their entrance into the canyon, the farthest nearly 75 miles. A number of faults, some with a dis-

FIG. 15

FIG. 16

FIG. 15—The boat *Grand* running a rapid two miles above Havasu Creek. (Photograph by E. C. La Rue.)
FIG. 16—Lava Pinnacle one and one-half miles below Lava Falls. Remnant of barrier of lava which at one time completely dammed the river. (Photograph by L. R. Freeman.)

FIG. 17

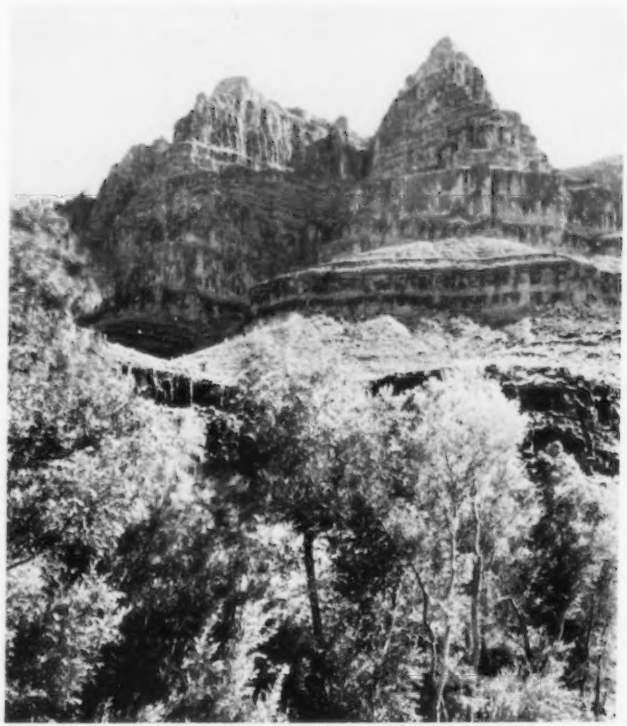


FIG. 18

FIG. 17—Looking down Separation rapid. This is the point at which three of Powell's men left in 1869 and at which the boat *Grand* capsized in the 1923 expedition. (Photograph by L. R. Freeman.)

FIG. 18—Peaks near head of Diamond Creek. An example of the magnificent scenery found in nearly all of the side canyons. (Photograph by L. R. Freeman.)

placement of the rock strata amounting to several hundred feet, crossed the canyon. The number and courses of the tributary canyons are evidently affected by these dislocations, but the faults have exerted no controlling effect on the main canyon. Nine miles above Diamond Creek we entered another gorge, carved in the crystalline rocks, the beginning of the longest granite gorge in the Grand Canyon. We consumed 10 days in running the 45 miles to Diamond Creek, and the boats passed through many small rapids.

Separation Rapid

After four days' delay at Diamond Creek, during which the boats and the equipment were overhauled, the party resumed its voyage. The boats plunged through one rapid after another as we moved through the deep and narrow granite gorge, which comes to an end only 13 miles from the lower portals of the Grand Canyon. Fourteen miles below Diamond Creek we reached Separation rapid, so named by Powell to designate the point where three members of his first expedition left the canyon only to be killed by Indians while they were climbing out to the north. The sheer walls forced everyone to ride the boats through these rapids, and the deck loads made the boats top-heavy and caused them to dance about in the torrent like corks, even when the cockpits were filled with water, giving us our roughest ride since the Sockdologer. One boat was upset.

Six miles below Separation rapid we reached a very bad rapid, reported by some of our predecessors to be the worst in the canyon. A lava cliff on the right bank just above the rapid is a landmark which suggests the name Lava Cliff rapid. Our boats were lined through the upper part by using long ropes held by men stationed at several points along the high cliff and were portaged around the lower part by taking them completely out of the water and dragging them over the rocks. The job of handling 900-pound boats was not easy, and a difficult portage of equipment added to the task; but this is the last bad rapid on the river.

The End of the Survey

On October 13 we finished our actual survey work, joining surveys carried from below upstream in 1920. We had carried our line for 251 miles without a break, running in this distance 84 rapids and many other stretches of rough water and portaging the boats past only three rapids.

At last we passed the west portal of Grand Canyon, 214 miles below the mouth of the Little Colorado, and, favored at times with a strong downstream wind, a rare occurrence on the Colorado, we rapidly made our way toward Needles, Cal. In this stretch the river was comparatively free from rapids or riffles, and after a time it became our concern to avoid grounding on sand and mud bars in the river, spread out at some places to a width of more than a mile. As we were all eager to finish the trip, we made practically no stops until we reached Needles on the morning

of October 19 and then lost no time in getting our boats out of the water and to the railroad station. One of the boats has been shipped to Washington and placed on exhibition at the Interior Department building.

Conclusion

This latest trip through the Grand Canyon has confirmed the outstanding conclusion reached by its earlier explorers—that it reveals everywhere, even throughout its most minute features, the impress of the rock formations in which it is carved. Strikingly unparalleled though it is in the magnificence of its scale and in the clearness with which it discloses the character and relations of its beds and systems of stratified rocks, still more striking is it in its abounding evidences of the complete control that the rock formations have exercised in shaping not only its general form but its infinitely varying details. The succession of alternating cliffs and terraces; the height of each wall; the width of each bench; the open, gently sloping spaces at the bottom of the canyon in some places and the narrow precipitous gorges in others; the details of the ornamental sculpture; the vivid colors; the width and the swiftness of the river; the patterns of the tributary drainage systems—all these depend upon the character and the relations of the rocks through which the stream has carved its way to the sea. The boldness with which the nature and the divisions of the rocks in every part of the canyon are displayed and the structure is laid bare is due mainly to the aridity of the region. The Grand Canyon is thus presented to us as a field in which the geographer and the geologist can together pursue studies of far-reaching interest—studies that disclose not only the action of forces now in operation but the action of ever-present forces that have been potent through the ages since the Colorado has been forming the mighty chasm that is now reckoned among the wonders of the world.

ACROSS GASPÉ*

By Frederick J. Alcock
Geological Survey of Canada

The Gaspé peninsula may well lay claim to being the oldest part of Canada. On its shores, near the site of the present town of Gaspé Basin, Jacques Cartier in 1534 erected a cross bearing the arms of France, signifying that he took possession for his country, and in Gaspé were made some of the earliest settlements of New France. But though the oldest it is far from being the best known section of the country. Poor means of communication long kept Gaspé isolated. Its very isolation, however, has given it a peculiar charm. Here one may see an everyday life which has remained much the same for the past two and a half centuries. Here are found descendants of French, Scotch, Irish, and English pioneers who have been little affected by outside influences. In late years, however, the railway has done much to break down this isolation and to advertise the attractions of the country. Metis on the north shore, Gaspé Basin at the eastern end of the peninsula, and Percé and other attractive summer places on the south shore annually draw hundreds of tourists. Lovers of fly-fishing find no finer sport than on the salmon streams of Gaspé, and hunters are attracted by its moose and caribou. The lumber trade has brought in still other people, but even yet there is a long stretch of coast line on the north side of the peninsula which has but little communication with the outside world.

The population of Gaspé on both the north and south shores is confined to a narrow strip along the coast. The whole interior is uninhabited and only partially explored. Old lumber roads ascend some of the main valleys for short distances, but elsewhere, except along the streams where canoes can be poled, one must travel on foot. A road up the Cascapedia valley has recently given access to a very interesting part of the interior, but elsewhere it is rare that parties go in far from the coast.

Crossings of the Peninsula

In the summer of 1923, in connection with his work of examining some of the mineral resources of southeastern Quebec and more particularly in completing the geological mapping of an area in the central part of Gaspé, the writer had an opportunity of crossing the peninsula from the River St. Lawrence to the Bay of Chaleur. Though a distance of merely some eighty miles as the crow flies, such a traverse across Gaspé has been made but few times owing to the barrier presented by the belt of high country which, under the name of the Shickshock Mountains, extends along the middle

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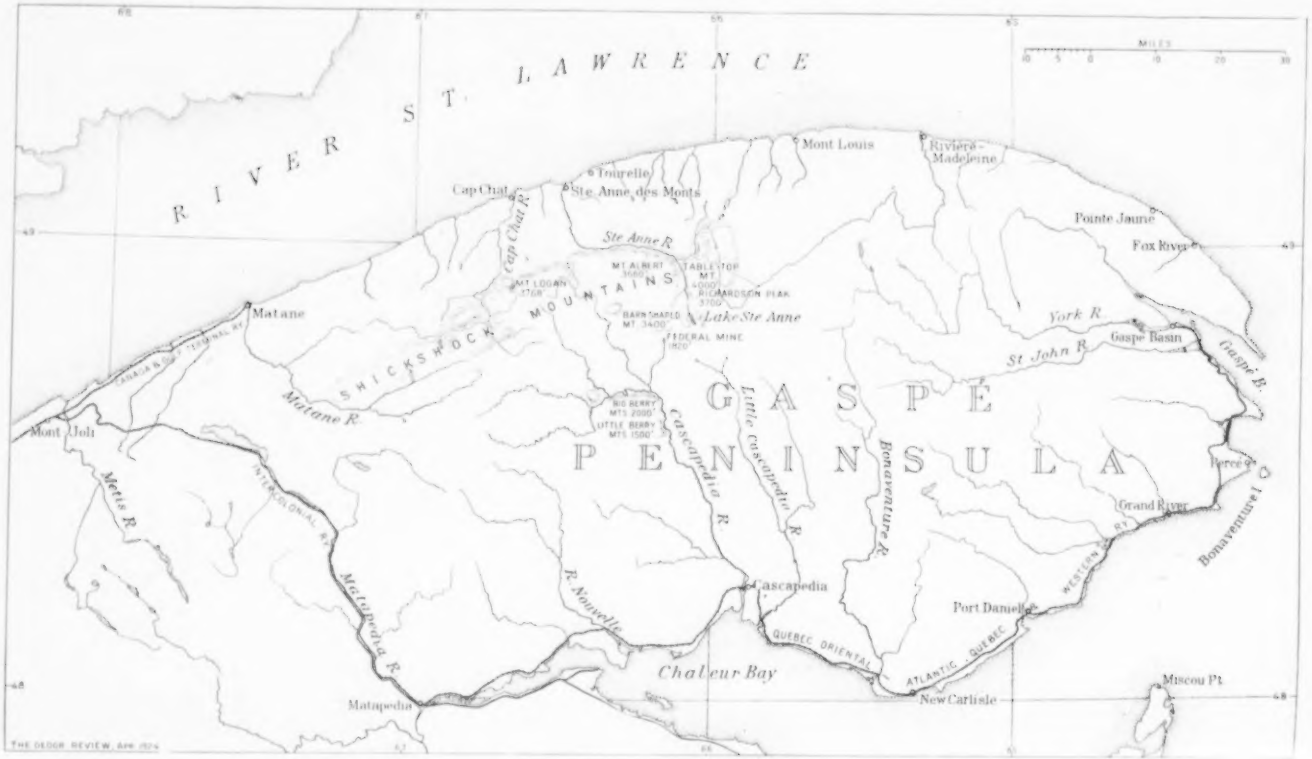

FIG. 1—Map of Gaspé showing the higher parts of the Shickshock Mountains. Scale 1:1,650,000.

of the peninsula. The Shickshocks are an extension of the Appalachian Mountain system of the eastern United States and form the highest land in southeastern Canada. Ascent to the mountains from several of the rivers which flow north to the St. Lawrence River or from the headwaters of the Cascapedia which drains to the Bay of Chaleur can readily be made and forms an interesting experience from many points of view.

The first recorded journey across the peninsula of Gaspé was made in 1844 by Sir William Logan, the founder of the Geological Survey of Canada. In 1842 Logan was brought from England to do geological exploration for the Canadian government, and his first work was an investigation of the geology of Gaspé with the object of determining the possibility of finding coal in the peninsula. His first field season was spent in studying and mapping the eastern and southern coasts. In the following year, after traversing much of the northern coast, he decided upon a trip across the peninsula to secure a complete geological section across the structure of the rock formations. He ascended the Cap Chat River by canoe to the mountains; several of the higher summits were climbed, to the highest of which his assistants gave the name Mt. Logan; and then the journey across the divide was begun. The canoes were abandoned, and with their meager equipment and supplies on their backs the party struck through the woods, Logan keeping a pace and compass traverse as he went. When southward-flowing waters were reached canoes were constructed, and the Cascapedia River was descended to its mouth. Logan's survey of his traverse across the peninsula proved to be remarkably accurate. He secured enough information to demonstrate the absence of coal in payable quantities in Gaspé.

Exploration of the rivers of Gaspé was continued by a number of Logan's assistants, principally Murray, Richardson, and Bell. It was not until 1883, however, that another traverse was made across the peninsula. In that summer, A. P. Low, who later became Deputy Minister of Mines for the Dominion government, mapped the Ste. Anne River as far as Lake Ste. Anne and from the top of Mt. Albert sketched many of the surrounding mountains. Later in the season he made a second ascent of the river to Lake Ste. Anne, portaged his canoes across to the headwaters of the Little Cascapedia River, and descended that stream to the Bay of Chaleur.

The North Shore

The route followed in the traverse described below was partly that used by Low and partly that of Logan, that is up the valley of the Ste. Anne and down that of the Cascapedia. The starting point was Ste. Anne-des-Monts where the Ste. Anne River enters the St. Lawrence.

Ste. Anne-des-Monts is one of the larger villages on the north shore of Gaspé. It can be reached either by steamer, which makes weekly trips in summer from Montreal calling at the principal ports of Gaspé, or by motor

bus which runs back and forth daily to Matane, the terminus of the Canada and Gulf Terminal Railway. The village is long and straggling, stretching out for a couple of miles along the coast. Behind it the wooded hills rise rather steeply leaving only a narrow fringe of farming land facing the shore. East of Ste. Anne-des-Monts the coast becomes still more abrupt with cliffs of limestone and shale bordering the shore for long distances.

The most striking feature of the whole north shore of the peninsula is its regular character. There are no long promontories and no deep bays to serve as natural harbors. Steamers must unload at docks built out into deep

FIG. 2.—Mont Louis, on the north shore of Gaspé, showing the characteristic terraces which furnish most of the habitable land on the St. Lawrence side of the peninsula. (Photographs are by the author with the exceptions indicated.)

water, as at Ste. Anne-des-Monts, or else by lighters. The smooth curved outline of the coast follows the structure of the folded rocks of the peninsula.

Here and there along the whole coast line are located small villages—wherever an entering stream makes a break in the regular shore line. The two important industries are lumbering and fishing. At the mouth of every stream is a sawmill which takes care of the spring drive of logs. Towards the eastern end of the peninsula each little village has its fleet of fishing boats. The principal catch is cod, much of which is marketed in Italy.

Nearly all the inhabitants of the north shore are French Canadians, and but few speak or understand English. Their houses are distinctive: curved roofs, dormer windows, and long verandas are typical features used with pleasing results. Outdoor clay ovens for baking bread are seen everywhere. The main feature of every village is the large church. Many of the churches are built in part of great stone blocks cut from granite boulders carried over from the north shore of the St. Lawrence by the ice in the glacial period. Little communication takes place between the villages east of Ste. Anne. A

FIG. 3

FIG. 4

FIG. 5

FIG. 3—Pointe Jaune, a fishing village on the north shore of Gaspé. (Photograph by C. M. Barbeau.)
FIG. 4—Fox River, a fishing village on the north shore of Gaspé.
FIG. 5—Tourelle, a typical lumbering village on the north shore of Gaspé.

wagon road follows the coast around the entire peninsula, but in some places on the north shore it runs along the foot of the cliffs and in others goes back into the hills where the grades are steep. In summer it is much easier to travel along the coast by boat than to make the journey by land.

Inland from Ste. Anne-des-Monts

The first part of the journey up the Ste. Anne valley may be made either by wagon or by canoe. The river is swift, and canoes must be poled. They are rarely taken above the forks of the river, a distance of thirty-two miles. The variety of canoe used is that known as the Gaspé model. It is a narrow, heavy craft about twenty-four feet long, able to stand hard usage, and is admirably suited for swift rivers where continuous poling but no portaging is necessary. It is commonly preferred to take any load up the Ste. Anne by wagon rather than by canoe, though the road after the first few miles is so rough that its advantage over the river route is but slight. The wagons used are light affairs drawn by a single horse, and the loads taken are small. The wagon road ends at Grande Fosse Creek, about twenty-eight miles from Ste. Anne.

The Interior of Gaspé

The interior of Gaspé is a plateau ranging in elevation from about 1500 feet to 4450 feet above the sea. From any summit where a view can be obtained a remarkably even sky line meets the eye in every direction, a succession of ridges of flat-topped wooded country with only here and there a peak or summit rising slightly above the general level. The plateau is dissected by deep youthful valleys whose streams are swift and frequently torrential. The summits of a few of the higher ridges are either bare or else covered with low scrub spruce. The valleys and valley slopes are heavily wooded. On the flat interfluvial areas the plateau quite commonly presents an open-wooded parklike appearance. Travel here is much easier than in the valley bottoms. The contrast between these flat areas and the steep valley slopes is very marked.

The two highest summits near the Ste. Anne River are Mt. Albert and Tabletop, between which the valley of the Ste. Anne forms a deep-cut trench. These two mountains, adjacent but strikingly dissimilar in some respects, are in many ways the most interesting in all Gaspé. Mt. Albert is the more commonly visited since it is more accessible and is a favorite hunting ground for caribou. A fairly good trail ascending the valley of the Plaque Malade, a stream which joins the Ste. Anne two miles above the Grande Fosse, can be followed to the summit. The mountain consists of a mass of serpentine surrounded by altered volcanic rocks. Its most notable feature is the flat summit. For a length of three and a half miles and a width of two and a half the summit surface is about as flat as the western prairies; a better comparison, however, would be with the northern tundras. The surface is rock-strewn and treeless, with here and there a small pond and along the

FIG. 6

FIG. 7

FIG. 8

FIGS. 6 and 7—Typical Gaspé houses. (Photograph Fig. 7 by C. M. Barbeau.)
FIG. 8—A Gaspé baking oven.

FIG. 9

FIG. 10

FIG. 11

FIG. 9—On the summit of Mt. Albert, showing the flat tundra-like surface.
FIG. 10—On the summit of Mt. Albert.
FIG. 11—The Ste. Anne valley from the summit of Mt. Lyall. Hogback Ridge is in the center with Mt. Albert on the left.

FIG. 12

FIG. 13

FIG. 14

FIG. 12—Botanist Dome, the highest point on Tabletop Mountain. Elevation 4450 feet.
FIG. 13—Open parklike country on the summit of Tabletop.
FIG. 14—On the summit of Tabletop.

depressions banks of snow which remain until late summer. On the contact zone of the altered volcanics (metamorphosed to a dark-colored hornblende schist) small scrub spruce grows in such dense masses that it is almost impossible to force a path through except along the caribou trails. In places the geological contact is sharply marked by this border line of vegetation. Though the area of serpentine has no trees, it offers an interesting flora of the arctic type; there is quite a variety of flowers, some of them peculiar to serpentine rocks.

FIG. 15—Lake of the Americans, a cirque lake on the west flank of Tabletop Mountain.

Mt. Albert has a maximum height of 4000 feet. On a fine day a good view of the St. Lawrence with its passing ships can be obtained, and even the north shore of the Gulf, at a distance of seventy miles, can be distinguished. Caribou are commonly to be seen, and sometimes one can get quite close to them. They apparently come to the summit during the mosquito and fly season to take advantage of the wind, which has its maximum effect on the broad exposed surface.

Tabletop Mountain on the eastern side of the Ste. Anne River presents some striking differences from Mt. Albert. The route to its summit from the valley of the Ste. Anne follows the northeastern branch for a distance of about two miles and then swings eastward towards the Lake of the Americans (Lac aux Américains)[1], a cirque lake on the western flank of the moun-

[1] The names "Lake of the Americans" and "Botanist's Dome" resulted from a botanical expedition to the region by Professors J. F. Collins, of Brown University, and M. L. Fernald, of Harvard University, in 1906. Regarding this Professor Fernald writes, "The name Lac aux Américains was given by our head guide, Samuel

tain. The summit of the mountain adjacent to the lake has an elevation of 3800 feet; but farther east one point, known as Botanist Dome, reaches an elevation of 4450 feet—the highest point in southeastern Canada. The mountain consists of granite with a fringe of older metamorphosed rocks. Its north-and-south length is about nine miles, and its width about five. All of this area is over 3000 feet in elevation. The surface is rolling, with here and there rounded domes of bare rock rising 500 feet or so above the general level. It has not the regular surface of Mt. Albert, to which the

FIG. 16—On the northeast branch of the Ste. Anne River showing huge granite boulders carried down by Pleistocene local glaciers from the side of Tabletop.

name Tabletop could have been applied much more appropriately; but its variety gives it a greater charm. On its surface are dozens of lakes and small ponds. The higher elevations consist of domes covered with huge blocks of gray and reddish granite. The depressions between are occupied in places by open parklike woods, and these with the grassy meadows and the lakes and banks of snow offer a most pleasing view on a bright day. Here and there, however, are areas of the inevitable scrubby spruce which make traverse difficult. The contrast of this open country with its variety of scenery to the wooded valleys of the peninsula where little can be seen but trees is both striking and agreeable.

Coté, and at the same time we gave various names which have been taken up, Lac Fortin and Lac Coté, for instance. These names had lasted in tradition among the guides and were first published by A. P. Coleman in Bulletin No. 34 of the Geological Survey of Canada, 1922. Coleman at that time originated the name Botanist's Dome because of the cairn on the summit built by our party.—EDIT. NOTE.

Mt. Albert and Tabletop are interesting as examples of physiographic old age. The granite intrusion of Tabletop took place in the Devonian, at which time were produced mountains which must have rivaled the present day Alps or Rockies. Through long periods of erosion the mountains were worn down. The flat surfaces of Mt. Albert and Tabletop are remnants today of this old peneplaned surface. Subsequent uplift, however, produced a rejuvenation of the streams, and valley cutting began again. The present topography of Gaspé is therefore one of youth carved beneath an earlier surface of great age.

Vertical movements of the peninsula have taken place down to recent times. Postglacial terraces are found on both the north and south shores. In fact, nearly all the habitable land on the St. Lawrence River side is in the form of raised beaches. A very prominent one, known as the Micmac beach, stands at an elevation of about 20 feet. Other beaches occur at levels up to over 400 feet. They rise perceptibly from east to west showing that the uplift was differential in character.

Glaciation

Perhaps the most interesting problem to the physiographer, however, in connection with the mountains of Gaspé is that of glaciation. Bell and Chalmers, of the Canadian Geological Survey, were both of the opinion that the Labrador ice sheet did not override Gaspé. More recently Professor A. P. Coleman, of the University of Toronto, spent two summers investigating the glacial problems of the peninsula and arrived at the same decision[2]—that the Shickshock Mountains, though occupied by local glaciers during the Pleistocene, escaped the erosion of the continental ice sheets. A climb to the top of Mt. Albert, Tabletop, Lyall, or others is enough to impress any one with this conclusion. The surface is strewn with boulders of the same variety as the bed rock. Along geological contacts there is but little overlapping of boulders of one type on the bed rock of the other. The irregular jagged knobs that project here and there would certainly have been scoured off had an ice sheet advanced over the surface, and there is an absence on the mountain summits of any smooth polished or striated surfaces such as characterize a glaciated region. The Labrador ice sheet when it reached Gaspé apparently divided into two lobes, one of which passed down the St. Lawrence valley and the other, spreading west of the higher Shickshocks, crossed Gaspé in the region of the Matapedia valley and extended eastward along the Bay of Chaleur.

Local glaciers were, however, undoubtedly present. The sides of the higher mountains present well defined cirques. The bottoms of some of these are occupied by lakes. The Lake of the Americans is of such an origin occupying a long cirque amphitheater. At the foot of the cirques are

[2] A. P. Coleman: Physiography and Glacial Geology of Gaspé Peninsula, *Canada Geol. Survey Bull. No. 34*, Ottawa, 1922.

moraines containing boulders of the rocks in place above, some of which are many times too large to have been transported by the present streams even at the time of spring floods. The interior of Gaspé was therefore a center of glaciation from which ice spread out to the north, east, and south.

From the height to which foreign boulders are found at present in Gaspé Coleman has estimated the thickness of the continental ice sheet in this region. It apparently had a thickness of less than half a mile. It is interesting to compare this figure with the estimated thicknesses of modern continental ice sheets. In Antarctica the surface of the ice sheet is nearly

FIG. 17—The Murailles, Percé. The shore is strewn with drying cod. (Photograph by C. M. Barbeau.)

level for hundreds of miles. In a distance of 1200 miles, Shackleton on his trip to the Pole found a rise of 3000 feet, which means, of course, a thickness of ice of less than this extent. It is probable that even in Pleistocene times a thickness of over half a mile was the exception rather than the rule. In Antarctica today mountains project through the ice sheet just as the Shickshocks of Gaspé must have done in Pleistocene times.

MT. RICHARDSON AND HOGBACK RIDGE

From Grande Fosse Creek, the end of the wagon road from Ste. Anne-des-Monts, to the Federal Zinc and Lead Mine, the end of the wagon road from Cascapedia on the Bay of Chaleur, is a distance of about twenty-two miles. A trail can be followed all the way, well cut out in part but in other places difficult to follow. It crosses and recrosses the Ste. Anne at a number of places, and every year new trees have to be felled for bridges. The writer's party made camps at suitable intervals along the route and flying camps up a number of the tributary streams. A trail leads up the valley of Poplar Creek to the Mt. Richardson country, one of the most famous of the Gaspé

summits. It has an elevation of 4000 feet, and from it can be obtained a good view of Mt. Albert to the west, and Tabletop to the east. It was named after John Richardson, one of the assistants of Logan who climbed it in 1857.

Still another mountain well worth a climb is the so-called Hogback Ridge. As the name suggests, the summit is narrow: it is 2900 feet high and bare of trees. From it one looks down the deep-cut valley of the Ste. Anne. On the west side stands the huge bare mass of Mt. Albert with a depression on its flank occupied by Devil's Lake, while on the other side rise the steep wooded

FIG. 18—A pile of dried codfish, Percé. Mt. Ste. Anne in the background. (Photograph by C. M. Barbeau.)

slopes of the plateau. To the south is an equally attractive view. There one sees the narrow summit of Mount Lyall and the red top of Sterling Mountain standing on either side of a valley occupied by Lake Ste. Anne, the source of the south branch of the Ste. Anne River. Hogback Ridge consists of fine-grained granite and is part of a continuous outcrop extending from the southern end of Tabletop westward to Barnshaped Mountain, a distance of about fourteen miles. This zone of granite is the upper part of a batholith of which the main Tabletop mass is also a part.

LAKE STE. ANNE

The trail from the Ste. Anne River to the Federal Mine leaves the Ste. Anne valley about half a mile below Lake Ste. Anne. A branch trail leads to the lake, a beautiful body of water three and a half miles in length and about one half a mile in width. It is divided into three more or less distinct parts by two narrows where deltas of sand and gravel have been built by entering streams. The southern part has a depth of 120 feet. Just why such a lake should exist in the heart of the peninsula and more particularly

why, situated south of the highest mountains, it should drain northward to the St. Lawrence forms an interesting physiographic problem.

The topographic map of the surrounding region brings out the striking fact that the tributaries of the Ste. Anne River for a considerable distance below Lake Ste. Anne all head southward, suggesting an original flow of this part of the Ste. Anne River to the Bay of Chaleur. The valley in which the lake lies is also a typical river valley and continues southward to one of the upper branches of the Little Cascapedia River; in fact a dam about ten feet high at the northern end of the lake would now send the waters south-

FIG. 19—Percé, showing the village, Percé Rock, and Bonaventure Island.

ward into the Little Cascapedia. Moreover, below the outlet of the lake bed rock occurs in the stream bottom at an elevation above that of the bottom of the lake, showing that the valley where the lake now lies could not have been excavated by a stream flowing northward to the Ste. Anne. On the other hand, the Little Cascapedia River where joined by the valley in which Lake Ste. Anne lies has an elevation lower than that of the deepest point of the lake. There seems to be no doubt, therefore, that Lake Ste. Anne occupies a valley which at one time was one of the important headwaters of the Little Cascapedia. There is physiographic evidence that the change from the south-flowing to the northward drainage was caused by capture in preglacial times. The lake itself had its origin in Pleistocene time and was caused by a dam of débris brought down by streams from the high plateau country to the west of the valley at this point.

THE FEDERAL MINE

The Federal Mine is situated on a hill overlooking one of the branches of Berry Mountain Brook, a tributary of the Cascapedia River. The hill has

been cleared of trees, and from it a beautiful view down the Berry Mountain valley to Big Berry Mountain can be obtained in one direction while to the northeast rises the broad mass of Mt. Lyall with the bare reddish top of Sterling Mountain showing beyond.

Interest in this region as a mineral country was first aroused in 1910 with the discovery of lead and zinc on what is now known as the Federal hill. Claims were staked which soon were in the control of two companies, under one of which, the Federal Zinc and Lead Company, much exploration and development work has been carried out. An excellent road has been built from the Cascapedia up Berry Mountain valley to the mine, a distance of ten miles, and the old lumber road up the Cascapedia valley has been so improved by the building of bridges and betterment of the grade that it is almost a new road. Camps are located at convenient distances of every ten miles along the road. The journey from the mine by wagon to Cascapedia station, a distance of forty-six miles, usually takes either two or three days. The underground work which has been carried out at the mine so far has been of an exploratory nature. A large amount of ore has been exposed, but lack of means of transportation has prohibited active mining and milling operations.[3]

The Grand Cascapedia

As already indicated, the route from the Federal Mine to the railroad on the Bay of Chaleur coast follows down the valley of Berry Mountain Brook to its junction with the Cascapedia and thence down the Cascapedia valley. For this second part of the journey the river itself offers an alternative route, and descent by canoe is quicker and pleasanter than by road.

The Cascapedia, or Grand Cascapedia as it is commonly called to distinguish it from the Little Cascapedia, a parallel stream about ten miles to the east, is the largest river in Gaspé. It is especially noted for its salmon fishing, while the headwaters of the stream are a favorite hunting ground for moose. Moose, however, are common throughout the peninsula. In his two seasons' work the writer saw a large number and in the fall of 1921 secured a bull on Lake Ste. Anne which had antlers of fifty-two-inch spread. Caribou are fairly abundant, but the favorite hunting ground for them is Mt. Albert. Deer are less common. Bear are reported in large numbers, but in the almost daily traversing of two field seasons not a single one was encountered although traces of them were often seen. Partridges are abundant and offer a welcome addition to the camper's larder in the fall.

Settlements of the South Shore

The village of Cascapedia is situated about five miles from the coast on the Quebec Oriental Railway which runs eastward along the Bay of Chaleur

[3] For details see F. J. Alcock: Geology of Lemieux Township, Gaspé County, Quebec, *Canada Geol. Survey Summary Rept.*, 1921, pp. 71D–96D, Ottawa.

from Matapedia on the Intercolonial. It is a small village separated into two rather distinct parts by the river. It is surrounded by rolling farm land. In fact, along the whole of the Bay of Chaleur agriculture is a much more important industry than along the St. Lawrence coast. The country rises more gently, and there are broader flats along the lower portions of the rivers.

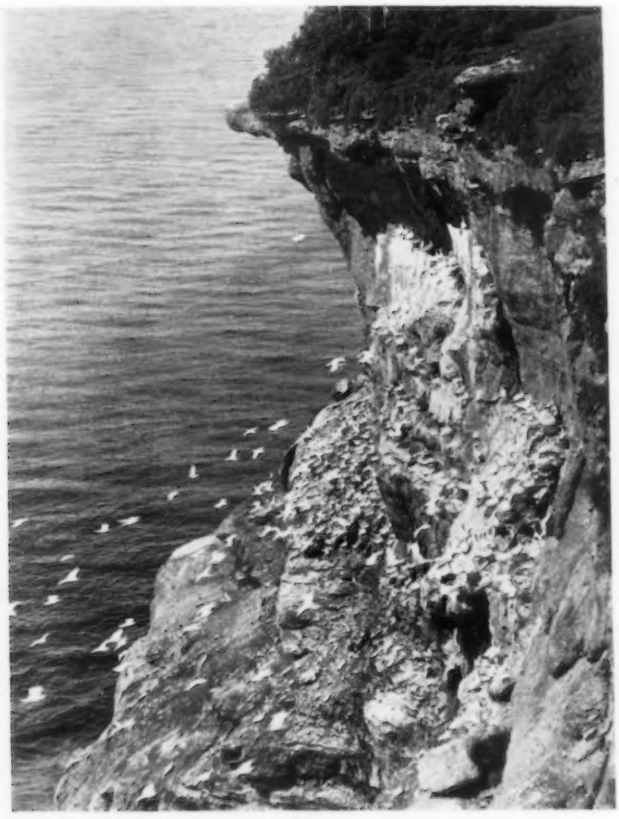

FIG. 20—Gannet Ledges, Bonaventure Island. (Photograph by P. A. Taverner.)

Another striking difference between south and north coasts of Gaspé is the character of the shore line itself. As already mentioned, the north shore is very regular, forming a broad smooth curve parallel to the structure of the folded rocks of the peninsula, with an entire absence of bays of any size. Along the Bay of Chaleur is a very irregular, varied coast. Deep bays, sandy beaches, and bay bars alternate with rock cliffs. The prevailing rock exposed in cliffs along the coast is a coarse sandstone-conglomerate formation of deep red color which makes a most attractive combination with the green of the woods and fields.

The population of the two coasts is also quite different. Along the north coast the people are mainly French Canadians of the *habitant* type. Along the south shore the Acadian French are in the majority, although here and there is found the *habitant* who has drifted in from other parts of the province. The two differ in both language and customs; as a rule the *habitant* is agricultural while the Acadian is a fisherman. Settlements of Scotch and of Irish are also to be found, sharply marked off from each other and from their French-speaking neighbors. Another important group on the southern and eastern coasts of Gaspé are the Jersey and Guernsey people who have for generations been fishermen on these coasts. In fact, from the point of view of race, language, and folklore Gaspé forms one of the most interesting parts of Canada.

Percé

No mention of the south coast of Gaspé would be complete without reference to Percé, the most interesting and beautiful point on the entire coast. Behind the village, a picturesque scene with its fleet of boats, its piles of cod, its lobster traps and fishing gear, rise the reddish cliffs of Mt. Ste. Anne, while to the immediate north of it stand the sea cliffs known as the Murailles. In front is the pierced rock from which the village takes its name, standing like a great mastless ship, 288 feet in height. Offshore at a distance of about two miles lies Bonaventure Island, whose red cliffs of flat-lying conglomerate are the nesting places of thousands of sea birds. The Island and Percé Rock are a bird sanctuary. The latter is the home of gulls and cormorants while on the former live gannets, puffins, and other species.

Of interest to the geologist is a monument which stands at Percé. On a low rock cliff in a small park is a bronze tablet to Sir William Logan. The park is known as Logan Park and has for its trustee the Geological Survey of Canada, of which Sir William was the founder. It is a fitting tribute to the man who laid the foundation for our knowledge of the geological history of Gaspé.

LOESS AND ROCK DWELLINGS OF SHENSI, CHINA

By Myron L. Fuller and Frederick G. Clapp

The character of the rural dwellings in all climes is normally determined by the nature of the materials available, their abundance, and ease of handling. In countries of advanced civilization, where transportation is highly developed, the æsthetic sense of the people may, it is true, cause the bringing in of materials, such as wood, brick, or stone, from distant points for use in dwellings. In less advanced countries, however, especially where building material can be brought from outside only by pack mules over narrow trails or by crude carts over almost impassable roads, it is inevitable that local material will be mainly utilized.[1]

Materials of unusual character commonly give rise to dwellings of like distinctiveness. Thus the loess of Shensi, China, soft and easily excavated, has given rise to peculiar artificial loess-cave dwellings. Nowhere else in the world is loess more typically or extensively developed; and probably nowhere else, except possibly in similar sections of the adjoining province of Kansu, are these novel underground dwellings so numerous or widely distributed. Yet even here an entirely different type of dwelling, the rock-cut house, is not infrequently seen where erosion has cut through the thick covering of loess into soft sandstones beneath.

The loess dwellings of Shensi, like those in other parts of northern China where loess is strongly developed, include constructional buildings of ordinary surface types as well as the cavelike excavations already mentioned.

Constructional Loess Dwellings

The constructional dwellings are square or rectangular in form, with wooden doors, mud chimneys, and one or more windows, usually admitting light through panes of translucent paper, often artistically arranged. The walls consist of loess, not infrequently mixed with rice straw or millet straw as a binder, placed while wet between forms of small rounded timbers laid horizontally, with opposing faces about a foot apart. As soon as the loess has dried and set, the forms are removed, and the surfaces, both inside and out, are given a smooth coating of loess plaster. Usually the walls are left with the natural yellowish loess color, which soon becomes, through weathering and the addition of wind-blown street dirt, drab-brown. Rarely, a coat of tinted limewash is added. Wall paper is used in a few instances.

Door and window frames are of hewn or hand-planed wood. The roofs may have a single, very gentle slope toward the rear but more commonly

[1] For illustrations see two recent articles in the *Geographical Review:* The Houses of Rural Brazil, by Roy Nash, Vol. 13, 1923, pp. 329–344; North American Indian Dwellings, by T. T. Waterman, Vol. 14, 1924, pp. 1–25.

are double-pitched, with front and rear portions of equal width and slope. These are slightly curving in the better dwellings. Roof beams are hand-hewn from trees, most frequently willows, which are usually sparingly scattered about the farmyards and villages. Upon these more or less crooked supports are placed sheets or mattings of brush stems, which are covered in turn by layers of wet loess mud, perhaps with more or less lime when this is available. The better dwellings have tiles over or replacing the

FIG. 1—Typical erosion topography in the thicker loess, showing plateau level, smooth slopes of old mature drainage, and recent gullying. Remnants of abandoned cultivation terraces are visible in the center.

mud. In some of the more elaborate structures and in those whose fronts are used as shops the corners and faces may be of smooth-faced yellow or bluish burnt brick.

Because of the limited coherency of the material, loess dwellings are never over a single story in height. The simpler dwellings consist of a single room; the larger ones may be divided by loess partitions, similar to the exterior walls, into two or more rooms. Floors are of the natural earth. On one side of the interior, a platform, *kang*, solid except for orifices for the insertion of fuel and flues for heat and smoke, is built of loess, brick, or the two combined, to a height of eighteen inches or two feet above the ground and of sufficient size to permit the inmates to stretch out to sleep upon a straw or reed mat laid upon its upper surface. Warmth is supplied by burning straw or other cheap material within the *kang* before retiring. A loess-mud chimney takes care of the smoke in most instances.

The constructional form of loess dwelling is found wherever loess occurs, either in its normal wind-blown form or in the closely similar reworked, water-deposited loess silts along the larger river bottoms as well as on the coastal plain outside of the area under consideration. In Shensi, consequently, these dwellings are distributed over the whole of the province north of the mountain face south of Sianfu. In cities practically all dwellings not of brick are of loess construction, the latter type likewise predominating in all the larger villages and even in the smaller ones that are of some age. It is only in the small scattered rural communities and in villages built since the Mohammedan rebellion that devastated northwestern China in the later sixties and early seventies of the last century, or subsequent to later depopulating droughts and famines, especially that of 1900, that they are subordinate in numbers to the loess-cave type next described.

FIG. 2—Excavated dwellings in loess bluff prepared by cutting vertical face. Upper tier of dwellings probably belongs to older series, dug when terraced yard in front was at higher level. Unusual loess-stair approaches are shown on left.

The loess house of constructional type, as compared with the excavated building, is easily and quickly erected, is more ornamental and attractive, is usually more accessible and convenient, is more readily ventilated, is less liable to leaks and collapse, requires only limited amounts of loess, is independent of topography, requires less space, and can be built in friendly proximity to its neighbor. On the other hand, it requires timber, often difficult or impossible to obtain, for its wall forms and roof and is far hotter in summer and colder in winter than the cave form. Tiling and bricks are entirely unavailable in many localities.

EXCAVATED LOESS DWELLINGS

The loess-cave dwelling consists of a chamber or chambers of arched-tunnel form excavated within the mass of any thick accumulation of loess. The length is ordinarily about 30 feet, and the height 14 or 15 feet. The width varies with the coherency of the loess at the particular locality.

When the lime content is high, the material is more coherent and will permit widths of 15 feet or more. When the loess is less calcareous, 8 or 10 feet may be the maximum width for safety. Probably the average width is about 12 feet. In very siliceous loess, such as is not infrequently found near the rivers and which is either water-deposited or water-sorted material subsequently transported and deposited by the winds, the coherency is often so low that the excavation of dwellings is dangerous.

The side walls are usually vertical to a height of 6 to 8 feet, above which arching begins. Usually the arch is semicircular as in Figures 3 and 6; but the elliptical arch, with longer vertical axis, as in Figure 4, is also common.

When loess is wet, there is more or less likelihood of flowage; when dry, it crumbles, spalls, and caves. The best time for excavating loess dwellings is, therefore, some days or weeks after a period of rain, when the loess is still moist but no longer wet. In this condition, it is easily cut and shaped without danger, the work being done with crude shovels or other implements of wood or metal. The material is removed in baskets and dumped in front to form a terrace serving as a front yard.

After the completion of the excavation, the inner walls are surfaced with a plaster of loess mud or of loess and lime, which prevents the loess from caving, as it otherwise would, upon drying on exposure to the air and the heat of domestic fires. The floor is left in its natural condition, soon becoming hard and compact with use. In the smaller dwellings, and in storerooms, granaries, stables, etc., the door may be simply a rectangular opening left while the excavation is carried on behind (Fig. 2). In other cases the front may be walled with stone. More commonly, however, fronts with doors and windows are built by placing wet loess mud between set forms such as are used for constructional dwellings (Figs. 4 and 6). Sometimes the fronts are given decorative patterns, more often by subsequent carving than by the design of the original forms. A false arch is not infrequently cut in the loess face over the real arch to give the appearance of added height, as in Figure 4.

The excavated dwellings commonly have but a single room, but the rear is often curtained off to form a storehouse, while adjoining dwellings are occasionally connected by passages through the loess (Fig. 5*a*). Similar passages may also connect the dwellings proper with storehouses or granaries, or with barns, as illustrated by the plan, Figure 5*b*.

A *kang*, or bed platform, is built in the front part of the dwelling and an earthen stove or oven for cooking in the rear. When the surface of the ground is not too far above the loess cave, small smoke shafts are sometimes constructed. The conical, or beehive, mound in the foreground in Figure 7 represents the surface termination of such a chimney. In many instances, however, the smoke is allowed to escape into the room and find its way along the top of the arch to an opening above the door, through which it passes to the outside air.

FIG. 3

FIG. 4

FIG. 3—Loess-cave dwellings at two levels on artificially terraced edge of plateau, with constructed loess village on top.

FIG. 4—Typical loess-pit village in Kansu near the Shensi border, showing form of pit faces, elliptical arched front of cave dwelling, and yard partition with impressions of the timber forms used.

Cliff and Pit Villages

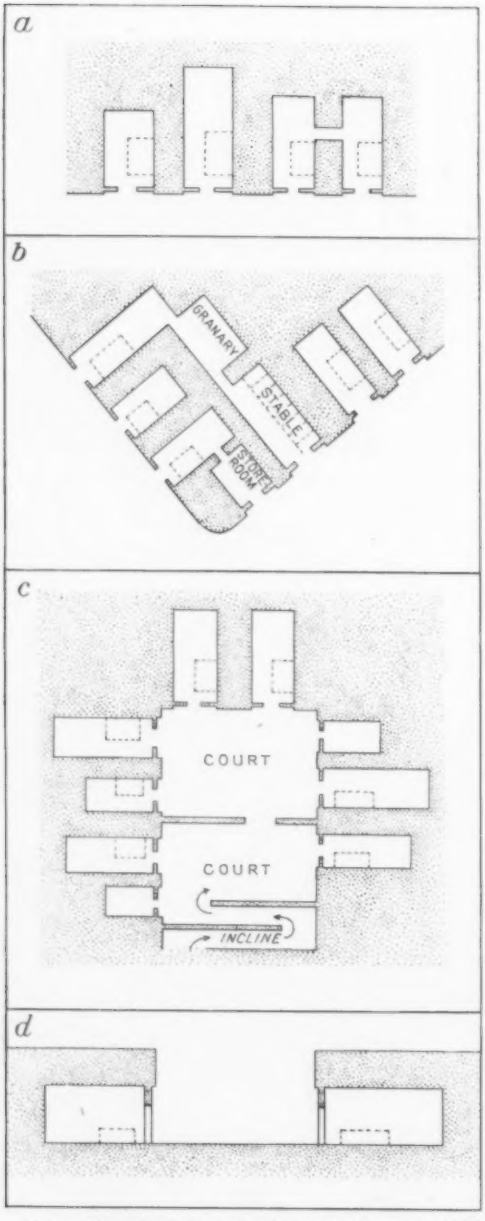

Fig. 5—Plans of loess-cave dwellings: *a* and *b*, rows of dwellings; *c*, loess-pit village; *d*, dwellings in section.

The loess cave dwelling is ordinarily dug in the face of a loess bluff. The bluff, if not already vertical, is made so before the work of excavation begins, usually being given a smooth face at the same time, as shown in Figure 2. Although loess caves are seen at two levels in this view, they are seldom or never originally constructed in this manner. In most cases, the upper series is the older, having been excavated when the yard platform or terrace in front stood at a higher level. When room for additional dwellings is required, the platform is lowered, leaving the older dwellings to be reached by ladders or, more rarely, by loess stairs, as in the figure. As a rule, the lowering is done only when the first series has begun to collapse or serious leakage through the overlying material has developed. In Figure 2 the face has been resmoothed after recutting, but not infrequently the face retains traces of the former terrace level. Figure 3 shows two terraces at the edge of a loess plateau, in both of which loess cave dwellings have been excavated. A loess village of constructional type appears on the plateau above.

So fixed has become the custom of digging caves in the vertical faces that, when no

natural cliff is at hand, the Chinese loess dwellers are impelled to make such a face artificially. On the loess plateaus, extending for miles without an inequality large enough to catch the eye, this may not appear an easy thing to do. It is accomplished, however, by first excavating a rectangular pit of perhaps an eighth of an acre in area and with vertical sides 25 to 30 feet high except at one end, where stairs are cut or, more often, an incline leading to the bottom is constructed (Fig. 6). In the sides of this pit the loess caves are excavated as in natural cliffs, the material being either removed to the plateau surface, to be used for making walls and buildings, or spread out on the ground. Figure 6 shows one of the pit villages, with a part of one of the dwellings, as seen from the top; while Figure 4 shows one as viewed from the bottom of the incline that affords access to the village.

The first essential of the cave type of dwelling is loess that is sufficiently calcareous to stand without caving. Not all of the loess possesses this requisite, the coherency varying greatly in different parts of the province. Although some very calcareous loess is found along the Hwang Ho and elsewhere in south-central Shensi, the lime content is, in general, highest in the relatively arid regions near its

FIG. 6

FIG. 7

FIG. 8

FIG. 6—Loess pit with round-arch cave dwelling in the mile-high loess plateau of northwestern Shensi.

FIG. 7—Conical, or beehive, chimney of an underground loess dwelling.

FIG. 8—Loess sink opening into an abandoned underground dwelling of the loess plateau.

supposed source in the Ordos of Mongolia or the desert regions of the northwest. In part this may be due to the more rapid deposition of the loess, which reaches its maximum development in northern Shensi and adjoining portions of Kansu, with a minimum of leaching during the process; in part to a smaller admixture of siliceous material than farther south where the material has often been water-transported and partly sorted before final deposition by winds; and in part to limited rainfall and leaching at the present time.

For these reasons, although the loess-cave dwellings are found in almost all parts of Shensi north of the Tsin-ling Range, the material is most suitable and the cave dwellings are most numerous in the north and northwestern parts of the province. In this region, the topography is likewise more favorable owing to the advanced dissection and the prevalence of natural cliffs. Although loess caves are excavated, as has been described, in the sides of large pits sunk in the smooth plateau surface, more than 99 per cent of them are dug in natural cliffs. Figure 1 is a characteristic view of the topography in the thicker and more deeply eroded loess accumulations. The plateau sky line, the smooth slopes of an old mature drainage, and the ravines and gullies of the recent period of rejuvenation are all well shown. The more rapid the recent erosion, the less the loess is leached and the more suitable it is for the excavation of dwellings.

The fact too that the region is geographically remote from other sources of building material also tends to make the loess cave most common in northern Shensi. There is but a single little-used cart road leading from the south, and this stops scores of miles from the northern border. Even the trails are steep, narrow, and few in number.

The cave dwelling, furthermore, tends to be most common in newly settled or resettled districts, in the same way that cabins and sod houses were pioneer structures in the woods and prairies of North America. Northern Shensi, again, most nearly approaches these conditions, for upon it fell the brunt of the depopulating Mohammedan rebellion of the sixties and seventies and the devastating famine of 1900. Traces of once cultivated terraces, abandoned at one or the other of these times, are found at many points and are seen in Figure 1. Only a comparatively small number of people have come back, and although a few cities have persisted, considerable areas are very thinly populated.

Because of the conditions outlined in the foregoing paragraphs, the loess cave is almost strictly a rural type of habitation, preceding the establishment of large villages. The number of cave dwellings, in the aggregate, is immense; and thousands of the inhabitants of Shensi are born, live, and die within their walls.

Loess caves, when properly cared for, last many years. When neglected, however, they soon collapse, partially or completely. Collapse is followed by a settling of the overlying material in the form of a sink, as shown by the depression in front of the opening in Figure 8, or sometimes by a loess well

such as is described and illustrated elsewhere in the *Geographical Review*.[2] On the mile-high loess plateau of northwestern Shensi many acres were found pitted with loess sinks and openings of the type shown in Figure 8, indicating the former existence of underground villages of far greater extent than anything encountered at present. These, we were told, were abandoned at the time of the Mohammedan rebellion in the late sixties. After nearly sixty years, the collapse is still far from complete. Where the

FIG. 9—Slab-roofed "boulder" hut.

covering of loess is considerable and the rainfall is light, there seems no reason why the caves should not last for a century or even longer if they are properly cared for and their interior is kept well plastered. The development of near-by villages, aside from war and famine, is probably the most potent cause of their abandonment; and even then their use as granaries and stables may continue almost indefinitely.

In times of earthquake, the loess caves become positive death traps, as was shown in adjoining sections of Kansu in the seismic disturbances of December, 1920, when the violently agitated loess flowed almost like water or crumbled into dust, accompanied by a heavy loss of life. Under ordinary circumstances, however, the loess caves afford comfortable shelters. The writers spent nearly a year in the loess region, many nights of which

[2] Myron L. Fuller: Some Unusual Erosion Features in the Loess of China. *Geogr. Rev.*, Vol. 12, 1922, pp. 570–584; see especially pp. 580–582 and Fig. 13, p. 583.

were passed in underground dwellings of the type described. Their warmth, after a day in the saddle in wintry weather, was far from unwelcome and greatly to be preferred to the benumbing cold of the *yamens* of the magistrates and other buildings of constructional types. Vermin are less common than might have been expected, the plastered walls and floors of compacted earth affording no lurking places.

Constructional Rock Dwellings

The persistency with which the Chinese cling to the cave type of dwelling, even to the extent of digging great pits to furnish the necessary loess faces for the excavation of their underground dwellings, is still further exemplified in their constructional rock dwellings along the Hwang Ho (Fig. 10). This and other large rivers have cut through the thick loess mantle and into the rock beneath to a depth of several hundred feet. Notwithstanding the fact that there is usually more or less recent loess on the rock slopes, the thinly bedded gray sandstone affords a large proportion of the building material.

Although the flat stones are admirably suited for the construction of ordinary rectangular walled and roofed buildings, this type is comparatively rare. Instead, the builders reconstruct in stone, to the best of their ability, the loess cave of their ancestors. The round arch and internal form are reproduced; the walls are plastered, the ends closed, *kangs* built, and the smoke permitted to escape in the same way. The roofs, however, are thinner, usually three to five feet in thickness, and consist of coverings of loess laid over the top of the arches and given a smooth surface. Sometimes the roof tops are surrounded by walls and used for storage purposes; sometimes they are allowed to become turfed with grass. The buildings usually contain from two to ten chambers (Fig. 10), a single-roomed structure being very rare.

A cruder type of constructional rock dwelling is that in which large boulders are utilized as sides, as in Figure 9. The roofs of such structures often consist of shaly slabs with coatings of loess mud. They are to be regarded as temporary habitations, such as would be built by shepherds, food sellers along the roads or trails, etc., and are most common where the slopes are too steep for the erection of the semi-cave type described above.

Rock Crevice and Rock-Cut Dwellings

The shelf or crevice dwellings of Shensi (Fig. 11) are comparable in situation to the cliff dwellings of America, being built on re-entrant shelves where softer layers have been weathered out from between more resistant beds of sandstone. It is not a common type, for, as a rule, the sandstones are very uniform in character and afford few benches adapted for building. Most of the shelf dwellings seen were in a single bed, more massive than usual and of limited extent, in the sandstone series (Permian?) in the vi-

FIG. 10

FIG. 11

FIG. 10—Constructed arched rock dwellings, of loess-cave design, along the Hwang Ho, eastern Shensi.
FIG. 11—Cliff dwellings on sandstone shelf, Yenanfu. The buildings are of crude type although provided with windows and chimneys.

cinity of Yenanfu in northern Shensi. The buildings here were of a crude type, although provided with windows and chimneys, as shown in the view.

Excavated, or rock-cut, dwellings are found in the more uniform sandstones, especially those approaching freestone in character. They are commonly cut in vertical faces at no great height above some rock shelf, talus slope, or loess terrace that affords a means of access. Ladders are seldom used, and rock-cut steps or approaches are uncommon.

The chambers of a single dwelling are sometimes several in number and are not infrequently on two levels (Fig. 12) connected by inside rock-cut stairways. The rooms are usually square or rectangular, with flat ceilings. Windows, doorways, and smoke openings are cut in the outer face.

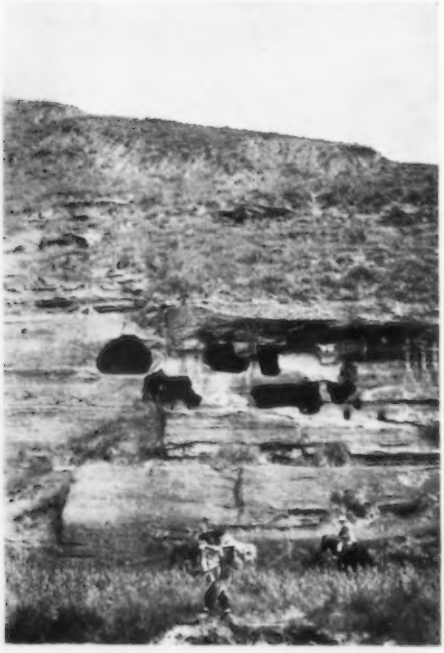

FIG. 12—Rock-cut dwelling of two levels in soft sandstone in northwestern Shensi, showing weathering of openings since abandonment.

The chief advantages of these dwellings are permanency, safety, and warmth in winter against which are the disadvantages of labor of construction and comparative inaccessibility. An idea of their permanency was afforded by the dwellings of Figure 12, in which the interiors of the rooms were found smooth and unchanged as though abandoned but a few years, although the weathering of the openings in the outer walls, several of which have become united into one, apparently indicates an age of several centuries.

Rock-cut dwellings are most numerous in the massive and comparatively soft reddish Permo-Mesozoic or Mesozoic sandstones, 1000 feet or more in thickness, in the extreme northwestern and western portions of Shensi; but they are occasionally found in the gray shaly sandstones (Permian?) of central Shensi, although suitable beds in the latter are rare. Although widely distributed and of considerable numbers in the aggregate, rock-cut dwellings cannot be considered common. There are indications that many of them were originally cut as temples and were appropriated and recut into dwellings after ceasing to be used for religious purposes. They are not popular, and comparatively few are occupied at the present time.

THE QUEBRACHO REGION OF ARGENTINA

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The quebracho forests of northern Argentina and southern Paraguay have the distinction of being the only forests of their kind in existence. Here and here only, between the 20th and 31st parallels, quebracho is found in sufficient quantities to permit commercial exploitation. Quebracho as a botanical species is not entirely confined to this particular region, but in no other portion of the globe has it been found to be so abundant and of so desirable quality.

The heartwood of the quebracho yields a valuable extract highly desired in the tanning of high-grade leathers and in such demand in both Europe and the United States for the last thirty or more years that this forest product has become of great economical importance. Foreign and domestic companies, principally the former, have invested large sums of money in forest holdings and in the establishment of tannic acid factories. The industry has assumed such dimensions that it is the leading factor in the development and colonization of northern Argentina.

Besides being utilized in the manufacture of tannin, the quebracho tree is converted into many other wood products consumed domestically. Chief among these are railroad ties, boards, beams, poles, piles, fence posts, and cross arms. It is also a desirable wood for certain general construction purposes but is limited in these uses because of its heavy weight and short lengths. It is fine-grained and takes a beautiful polish as well as being the hardest, heaviest, and most durable wood known. In fact in Argentina, especially in the quebracho region, this wood is put to almost every use for which wood can be employed.

According to official statistics[1] the total area of forest land in Argentina is 264,012,000 acres, which is 36.1 per cent of the land surface. This, however, includes some burned-over forest land and also a good deal of woodland, open and scrublike. The great bulk of the forest is located in the northern part of the country. The quebracho region alone is estimated to cover 100,000,000 acres, or 13.7 per cent of the total land surface of the republic; but only 45 to 60 per cent of the region is actually timbered.

The term quebracho is of Portuguese derivation, literally meaning "break ax." Unfortunately, in parts of South America the term has been indiscriminately used, being applied to any wood having sufficient hardness to turn an ax. In the quebracho region, however, quebracho has a definite meaning, for the reason that it is practically the only wood accepted and

[1] Raphael Zon and W. N. Sparhawk: Forest Resources of the World, 2 vols., New York, 1923; reference in Vol. 2, p. 667.

used by the tannin factories. Hence the woodmen are forced, under penalty of profitless labor, to seek the true quebracho in their operations. Two other types of quebracho are found in this region. The one is quebracho blanco (white quebracho), and the other quebracho colorado (red quebracho).[2] Both contain less tannin than the true quebracho and hence are in much less demand.

Quebracho blanco occurs in the forest composition with the true quebracho, distributed throughout the greater portion of the entire region, and is most commonly found where moisture is plentiful. The wood, a yellowish white in color, close-grained, hard, strong, and heavy, is used locally in the manufacture of such wood products as boards, cabinetwork, and cart parts.

Quebracho colorado (red quebracho), commonly known in the quebracho region as *quebracho santiagueño*, is exploited to some extent in the province of Santiago del Estero, the western part of the region, whence its name. It is used locally in the manufacture of most of the wood products to which quebracho blanco is put in other sections of the region.

The true quebracho[3] (*Quebrachia lorentzii*, of the family Anacardiaceae), commonly known in Argentina as *quebracho chaqueño* and occurring most abundantly in the province of Santa Fé and the territories of Chaco and Formosa, is the real quebracho of commerce and the quebracho with which this paper is concerned.[4]

Geographic Aspects

The quebracho region is characterized by being low-lying and monotonously flat. In fact it is so low and so flat that drainage from the area is both slow and difficult. There are many small watercourses, periodic in character, formed from the rains of the wet seasons and constituting *arroyos* during the dry seasons. A large portion of the rainfall finds no surface outlet to the sea whatever, remaining on the ground and forming *esteros*, *bañados*, *lagunas*, and *cañadas*. Evaporation and seepage remove some water, but during the rainy seasons much of the region resembles a large swamp. Railroads and houses at such times are often the only objects over leagues of land that stand free from the stagnant water.

A natural underground water system exists, but what feeds this underground water system is as yet problematical. Seepage from the Paraná River along the eastern boundary of the region and the heavy rains no doubt figure largely in its supply.

The surface soil for the most part is alluvial in character and where free from alkali is fertile. Four to ten feet of this surface soil covers a solid hard-

[2] These two species belong to the family Apocynaceae and botanically are known as *Aspidosperma quebracho blanco* and *Aspidosperma quebracho colorado*, respectively.

[3] C. D. Mell and W. D. Brush: Quebracho Wood and Its Substitutes, *U. S. Dept. of Agric., Forest Service Circular No. 202*, 1912.

[4] This article is based on the writer's experiences while connected with the quebracho industry in northern Argentina during 1922 and 1923.

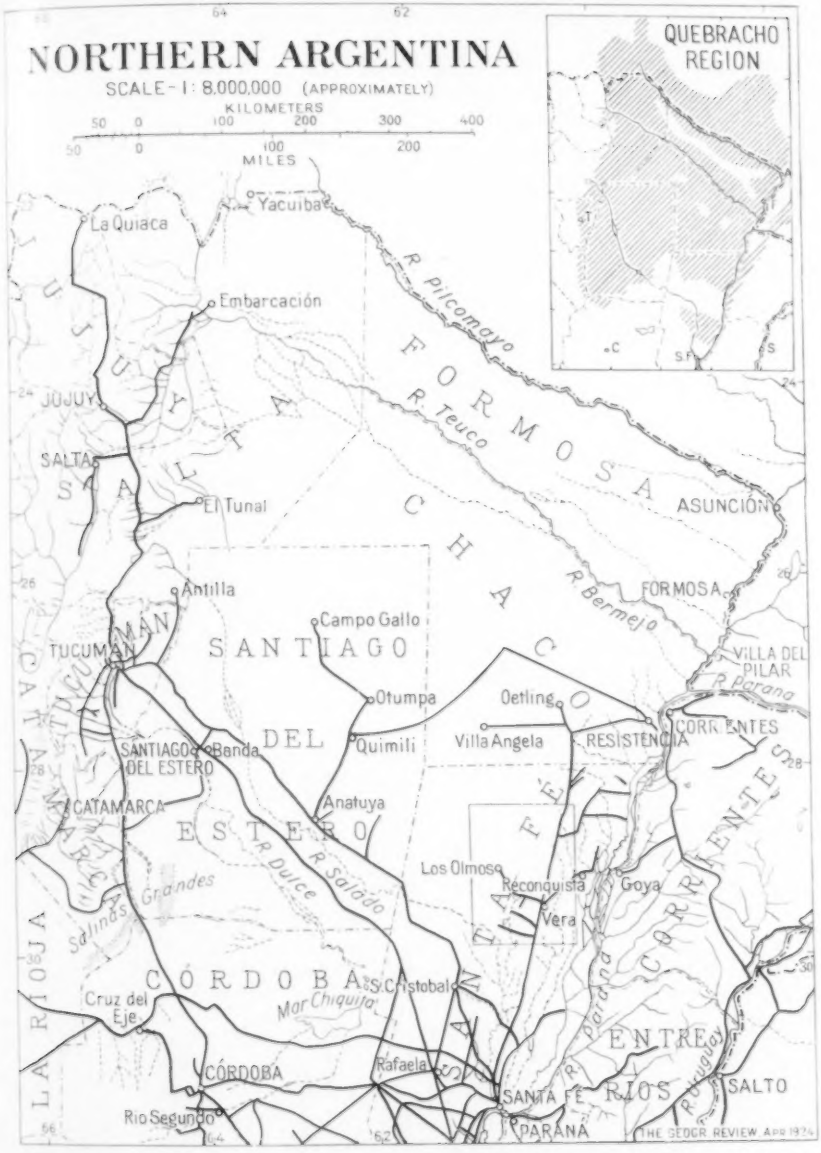

FIG. 1.—Location and railway map of the quebracho country of northern Argentina. The area of the rectangle in northern Santa Fé is shown on an enlarged scale in Figure 2. The inset, on a scale of 1:26,000,000, shows by diagonal ruling the distribution of quebracho forests with their extension into Paraguay (from Zon and Sparhawk: Forest Resources of the World).

pan of several feet in thickness, through which it is necessary to bore to tap the subterranean water. During the dry season, when the surface water has either disappeared entirely or has become too stagnant for use, bored wells become a necessity of life; when they are lacking, the population suffers as much from thirst as from the excess of water during a rainy season.

The subterranean water system exhibits an interesting peculiarity. At one point water may be found to be fresh and potable while but a few feet away the water may be salt and brackish. This condition is unique, as is

TABLE I—RAINFALL, 1911 TO 1912 INCLUSIVE, AT LAS GAMAS, PROVINCE OF SANTA FÉ*

(*In Millimeters*)

	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	MONTHLY AVERAGE
Jan.	82	166	70.5	177	205	49	40	152	91	201	67	28	110.7
Feb.	58	58	120	130	265	86.5	758	90	86	170	148	37	167.2
Mar.	23	85	99.5	238	99	36	10	374	339	27	101	56	123.9
Apr.	64.5	191	182	529	296	83.5	71	60	21	171	25	132	152.2
May	74	142	39.5	129	151	83	42	107	99	26	6	15	76.1
June	33	83	9	66	54	4	21	38	226	37	3	47	51.7
July	48	25	4	46.5	32	27	50	7	240	53	9	69	50.9
Aug.	22	20	19.5	21	15	45	8.5	15	2.5	69	14	39	24.2
Sept.	60	16	21.5	64	22	16	54.5	49	22	31	48	166	47.5
Oct.	5	116	70.5	160	33	55	72	117	118	64	41	36	73.5
Nov.	175	158	246.5	223	53	57	15	281	90	61	32	57	120.7
Dec	172	262	163	281	114	88	126	39	37	140	43	42	125.6
Yearly Total	816.5	1322	1045.5	2064.5	1339	630	1268	1329	1371.5	1050	537	724	

*The position of this station is approximately latitude 29° 30′ S., longitude 60° 20′ W.

the occurrence of the quebracho forests themselves. One of the explanations suggested in accounting for the occurrence of quebracho in this particular part of the world is the existence of this peculiar underground water source. It is thought that there is some definite relation between this system and the existence of quebracho. It has been established that water originating from subterranean sources within a belt or patch of quebracho forest invariably is salt and brackish, while ground water beyond the limits of any quebracho growth is invariably fresh.

In general, from the standpoint of personal comfort the climate of the quebracho region cannot be described as agreeable, though it is healthful for the most part except in the more swampy districts or during a prolonged wet season. Fanned by the hot and often humid north winds from the

interior of the continent, the region for days at a time in the summer season compares well to the blistering heat of a baking oven. At intervals these hot spells are broken for short periods by reverse winds from the south. Violent thunderstorms accompanied by torrential showers are frequent during this season. The thermometer has often been known to drop twenty-five degrees Centigrade within half an hour. In winter, the drier season, the south wind prevails, and comparatively low temperatures are experi-

TABLE II—RAINFALL FOR THE YEARS 1921 AND 1922 AT OTHER STATIONS IN THE PROVINCE OF SANTA FÉ*

(In Millimeters)

		JAN.	FEB.	MAR	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Santa Felicia	1921	154	155	132	30	18	11	11	11	70	113	49	64
	1922	67	81	104	129	36	74	52	80	185	51	68	44
Intiyaco	1921	75	82	53	48	30	20	10	18	44	113	68	88
	1922	99	30	37	188	58	67	93	30	66	64	107	67
Ombú	1921	80	78	63	40	32	24	8	14	38	101	72	153
	1922	71	45	55	101	79	68	48	39	66	58	107	18

*Approximate positions: Santa Felicia, lat. 29° 25′ S., long. 60° 15′ W.; Intiyaco, lat. 28° 40′ S., long. 60° W.; Ombú, lat. 28° 20′ S., long. 60° W.

TABLE III—MAXIMUM AND MINIMUM TEMPERATURES FOR THE YEARS 1921 AND 1922 AT SANTA FELICIA, SANTA FÉ

(In Degrees Centigrade)

		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1921	Maximum	39	36	32	32	32	29	34	34	30	31	35.5	42
	Minimum	17.5	18	12.5	9	6.5	−.4	−.3	2	6.5	2.5	8	14
1922	Maximum	42	37	36.5	35	28	27	29	27	27	32	37	40
	Minimum	13	12	12	8	4	0	7	4	7.5	9	10	15

enced. In the territory of the Chaco and the northern part of Santa Fé temperatures as low as −4° C. are observed on an average of two or three times a year between May and September.[5]

As a whole the climate of the quebracho region is variable and extreme. The rainfall varies from month to month and from year to year. It also varies markedly with different localities. In general, heavy rains are expected during the months of March and April and of November and December. The erratic nature of the distribution has been commented on by Lütgens.[6] It is illustrated in the tables of rainfall, I and II, which with Table III

[5] W. G. Davis: Climate of the Argentine Republic, Buenos Aires, 1910, p. 21.

[6] Rudolf Lütgens: Beiträge zur Kenntnis des Quebrachogebietes in Argentinien und Paraguay, *Mitt. Geogr. Gesell. in Hamburg*, Vol. 25, 1911, p. 1–70.

are from the climatological records of La Forestal, Ltda. The same feature is seen in the records from stations in Formosa and the Chaco published by the Argentine Meteorological Office in the *Boletin Mensual*.

Colonization

The northward trend of emigration into the quebracho region from the more settled sections in the southern part is coincident with the advance of the forest industry. As the more easily accessible portions of the forests are worked out and the wood supply becomes exhausted the operations advance into fresh unexploited areas. This is more particularly true of the eastern part of the region; in the west in Santiago and Salta, as Pierre Denis has pointed out, the pastoralist has led the way in many instances.[7]

In the areas of exploitation railroads and towns have been built through the medium of governmental and private aid. Much remains, however, to be done in the way of agricultural development, as the region is at present dependent on food products brought in from outside sources. Except for cattle in limited number it produces practically nothing in the way of foodstuffs. All of the towns and villages are located immediately adjacent to the railroads. Beyond a distance of five miles or so from any railroad the region is one vast wilderness.

Within a zone twenty miles in width extending along the banks of the Paraná River colonization has taken on a more serious aspect, not only on account of accessibility but also by reason of greater soil fertility. This belt is particularly adapted to the cultivation of citrus fruits, and profitable yields of other agricultural products are also secured.

One of the drawbacks to agricultural development in the quebracho region is the plague of locusts which during four months of the year—November to February—arrive in such numbers that they are beyond human control. These locust invasions lead to serious if not total losses. As the region becomes more settled and the population increases, the pest will no doubt be exterminated.

At present colonization in the interior of the quebracho region progresses only when the quebracho industry requires new territory for exploitation. The region has no attraction for the settler except the forest, and a profitable development of this resource is beyond the man of ordinary financial means. Hence colonization is slow and irregular, and from an economic aspect its progress is discouraging.

A few of the progressive ranchers of the region who have located on the numerous open *esteros* have endeavored to raise cattle as a business. Some success has been attained with this enterprise, but sooner or later it has to be associated with the forest work or it becomes unprofitable. Cattle are raised in the region in large numbers but for the most part only to supply the

[7] Pierre Denis: The Argentine Republic, transl. by Joseph McCabe, London, 1922, p. 113.

local demand for meat, which is always limited, and for fresh bullocks for the forest work.

Exploitation of the Quebracho

The prevailing method in the region for the exploitation of quebracho forests is an extremely simple process. It consists of felling the tree by means of an ax, cutting the main trunk and the branches if over eight inches in diameter from the remainder of the tree, and then removing the white sapwood, which is usually from one to one and a half inches thick and forms about thirty per cent of the entire wood contents of the tree. The red heartwood is left in the form of a log, *rollizo*.

The *rollizos*, varying in weight from 100 kilos to 3 tons and over, are then removed from the forest by bullocks, who drag them through cut *picadas* to the carts upon which they are loaded and hauled over roughly constructed roads to the *playa*, or receiving yard. The *playas* are invariably located at a railroad terminal or siding, *desvio;* and here the *chatas*, flat cars, are loaded with the wood for further transportation to factory or seaport. Arriving at a *playa* the cart and its load of wood is weighed at the *balanza*. The *carrero* receives a receipt for the delivery of this wood and returns to the forest for a new load.

Light portable railroads of the Decauville type have been used in some instances in place of the bullock and cart, but this has not proved satisfactory. The present unsystematic methods can be greatly improved; as yet no definite plan or scheme of procedure in exploiting the forests has been tried. Present methods are based only on one principle, namely to remove the wood from forest to railroad in any convenient manner. If this happens to be an efficient undertaking so much the better, but more often it results in a miserable complexity of unprofitable human effort. The *contratistas*, forest contractors, always remove the best and most accessible material with a view to making the most immediate profit. This is the natural procedure in any country where forests are in abundance, but it is to be regretted that a resource so valuable and so limited in world distribution as quebracho is wasted in this manner.

Furthermore, every dry season thousands of tons of quebracho wood are destroyed through forest fires. No organized effort has ever been made to control them. Forest fires are recognized in the region as being damaging and unprofitable occurrences, but on the other hand the very inhabitants who acknowledge this to be so are often directly responsible for large fires. Forest fires are disliked, as even the most humble peon will assure you, but no effort will be made by him or his companions to prevent or extinguish one, except it be in the immediate vicinity of his property and family.

The work of exploiting quebracho is only profitable within limited distances from the railroads. Five kilometers is a desirable haul, while fifteen kilometers is considered a maximum haul; although quebracho logs have been hauled for much greater distances by bullocks and carts. The

five-kilometer haul is the most profitable in all kinds of weather. During a dry season a *carrero* will haul from two to three tons of wood per cart with four bullocks, for a distance of five kilometers, and make two return trips a day. In a rainy season the load must be reduced by fifty per cent at least, and the trips must be limited to one return trip a day. Often the roadbeds are not in condition to permit of even this haul. During a period of bad road conditions the *carrero* with his cart loaded often finds it too heavy for certain stretches of the muddy roads and hence must unload a portion before being able to resume the journey. Although he endeavors to use judgment in loading the proper amount in the beginning, soft spots in the road develop rapidly and upset his calculations.

Such transportation methods are costly. In the spring of 1923 the following prices were being paid for woods work. From 6 to 8 pesos per metric ton were paid for wood *tipo exportación*, export type, delivered in the receiving yard. This delivery cost is distributed as follows: 1.50 to 2.50 pesos to the *hachero* for felling the tree and removing the sapwood; 4 to 5 pesos to the *carrero* for hauling, furnishing his own carts and bullocks, with possibly some outside assistance; 50 centavos for loading the wood on the carts in readiness for the journey.

Hauling three tons twice a day figures from 42 to 48 pesos per cart per day. This is rather an attractive figure; but, as a matter of fact, a profit of from 5 to 10 pesos per day per cart for such work, day in and day out, is the average amount realized. Bad road conditions and the general retrogressive effects of too much water in the wet seasons and too little water in the dry seasons make forest operations difficult from a number of standpoints.

The forestry industry of the quebracho region is equally as dependent on the railroad for provisions and foodstuffs in general as it is for the transportation of its wood. The *obraje*, forest working center, has no source of food supply of its own on the spot. Potable water is extremely limited, and often the railroad is required to bring water as well as food into the region.

Reference has already been made to the hydrography. Over much of the region and particularly in the Santiago section there is a complete absence of running water of any kind. The underground water supply is little known or inaccessible and salty. In order to meet the demand for water shallow reservoirs are dug which resemble the *represas*, diked basins, on the ranches in the south. These shallow basins fill with rain water and are usable for temporary periods; but with the arrival of dry spells they become stagnant green pools, and the population has to rely on wagon cisterns or leave the work. Huret has described the provisioning of water at Quimili in Santiago del Estero. Every week 9 trains of 40 wagons each holding 20,000 liters of water leave Anatuya for the sawmills of Quimili and vicinity.[8]

[8] Jules Huret: En Argentine: De Buenos-Aires au Gran Chaco, Paris, 1912, p. 300.

Many small *obrajeros* and *contratistas* operate independently in outlying forested sections of the region. They find a market for their cut wood at the various tannin factories. Some exploitation work as carried on by the large tannic acid concerns is done directly through administrative control, but when possible these companies prefer to secure wood from their own forest holdings by awarding contracts to numerous *obrajeros* and *contratistas* who in turn portion out their obligations to smaller operators. In every instance, however, *contratistas* and *obrajeros* are responsible to the parent concern, and their independence is curtailed especially with regard to prompt delivery of the wood to the factory centers.

The worker in the forests is of necessity an early riser, the nature of his task requiring that he devote long hours to the work. His breakfast is simple, consisting of *maté*, Paraguayan tea, sipped from a gourd. The cartmen then tie in their bullocks, which are kept over night in a near-by corral, and drive off to bring in the wood prepared by the axmen. The bullock herder takes his charges to pasture, and the *jefe*, or chief, mounts his horse to visit the camps of the axmen or to go to the *playa* for meat or provisions.

The *hacheros* generally live in tents or other types of temporary shelters conveniently located to their work but always at some distance from the *rancho* of the chief. They work stripped to the waist, squaring the felled trees into logs, balks, and railroad ties or removing the bark and sapwood, leaving the *rollizos* for exportation. They work at night by moonlight when possible to avoid the excessive heat of the day if in summer. Their food consists of large biscuits called *galletas*, which are dried and hardened to the consistency of flint. These they soften in a soup made from fresh meat or the dried salt meat, *charqui*. To this soup is added rice, maize, or *fideos*, a coarse macaroni. The favorite roast, *asado*, is made from the ribs of beef impaled on a stick and placed near the fire until sufficiently cooked. Water and coffee are the usual beverages. The native "coffee" of the region is made chiefly from beans or maize with a large percentage of chicory added to give it body.

The forest workers of the quebracho region are nomads, and as the woods become exploited they move on to fresh camping grounds, leaving the woods to revert to their former solitude—a haunt for the wild animals who creep back to revisit old scenes once silence has returned. Among these people one finds the primitive idea of hospitality in the form of an unaffected welcome and willingness to give of the best that they have. They have no thought for the morrow or what will be their lot when too feeble to work. Yet they are a happy and contented folk.

The estimated quantity of quebracho at present in the quebracho region is at best a doubtful figure. Based on a number of recent surveys, the writer places the total amount at about 150,000,000 metric tons.

The present average yearly consumption of this wood for all purposes is approximately 1,000,000 tons. The yield of quebracho per acre is very

variable. The writer has examined many acres which have tallied over 10 tons of quebracho as well as many which would produce less than a ton. Two tons of quebracho heartwood per acre is generally accepted as being the average yield. On this basis, in order to satisfy the demand, it is necessary to cut over about 500,000 acres yearly.

The forests of the quebracho region are so distributed that from 40 to 60 per cent of the area is lacking in any tree growth. Hence the estimated amount of quebracho is to be found on an area of approximately 50,000,000 acres, which, in accordance with the writer's estimate, implies an average yield of three tons of wood per acre. On this basis 333,333 acres are cut over annually to supply the demand, and 150 years will be required to exhaust the resource. Considerable discrepancy necessarily exists among calculations of this character because of the inaccuracy of the available basic data. Destruction by fire also reduces the available tonnage. It is thought that loss from this source at least equals the total amount of current growth of the forests.

The quebracho is not so slow-growing a tree as has been commonly supposed. Some 40 years will produce a tree of desirable size for the manufacture of extract.[9] Such a tree gives 200 kilos of heartwood at this age. Posts and poles can be produced in a much shorter period, 20 to 40 years.

Because of the relatively higher value of the true quebracho as compared with the red quebracho, and because of their similarity in general appearance, the latter is often substituted for the former. Urunduay, which resembles quebracho in general appearance and which is found in large quantities growing intermingled with quebracho, is also often substituted. The red quebracho has a small tannin content, Urunduay has none at all. Technically their differences are well distinguished.

Curupay bark, the wood of the Algarrobo negro tree, and the bark of two trees known as cebil, all of which are found in the vicinity of the quebracho region, have in the past been preferred domestically for tannin purposes. It is a well known and generally accepted fact that Algarrobo negro produces, by the same process as is employed in the extraction of tannin from quebracho, a quality of tannin much superior to quebracho itself; but because of the limited and scattered supply it cannot be economically manufactured.

The Forests

In general, one prevailing forest type is found throughout the entire region. This type is composed principally of quebracho species as already described. The forests grow in well defined belts and patches as a rule. They are found on the slightly elevated areas away from the *cañadas* and *esteros*. While during the rainy season the entire forest floor of the region is water-soaked and often completely covered, quebracho seems to prefer the higher localities from which the surface water drains more readily.

[9] W. D. Durland: Notes on Quebracho Colorado, *Journ. of Forestry*, Vol. 21, 1923, pp. 600-603.

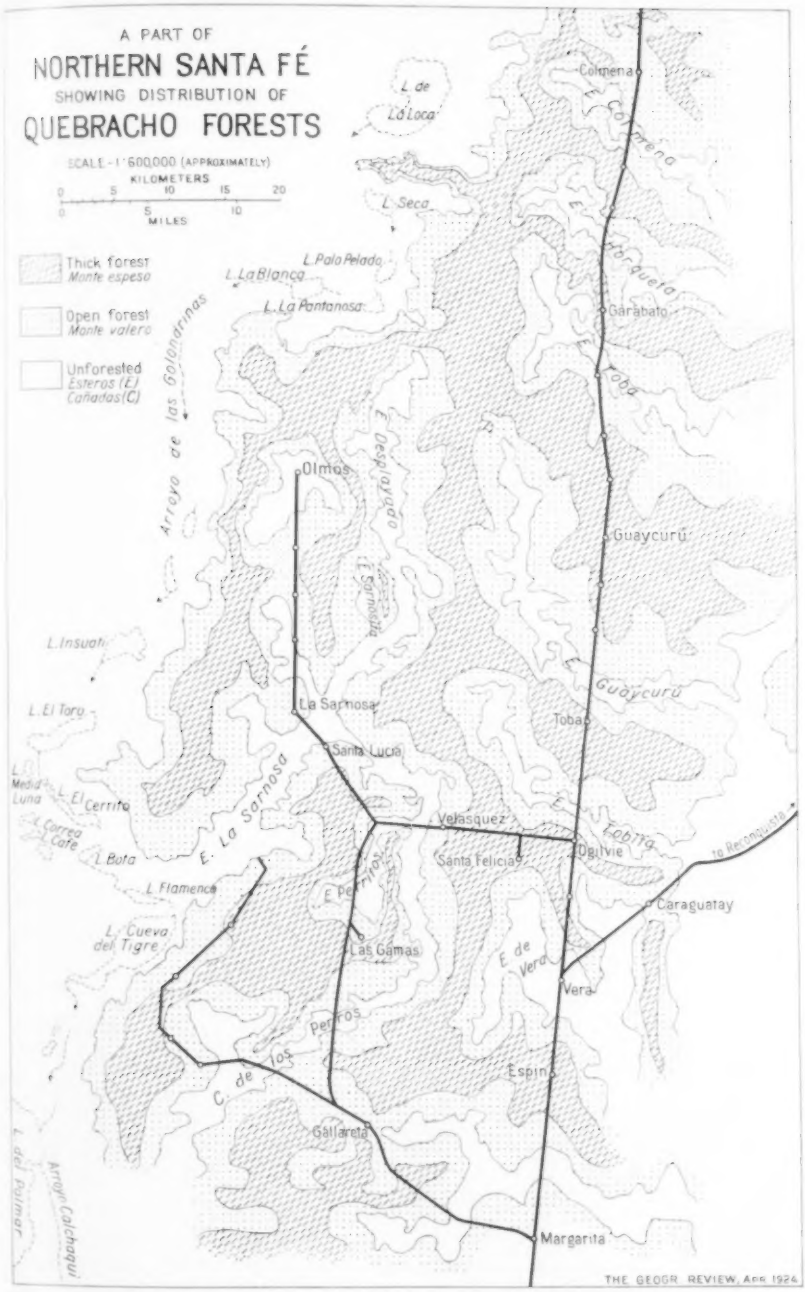

FIG. 2.—Sketch map of a section of the quebracho region in the northern part of the Province of Santa Fé, showing the structure, formation, and general manner of occurrence of quebracho forests. Constructed by the author from reconnaissance notes. See the map, Figure 1, for location.

The explanation is offered that fire is in part responsible for this belted and patchy occurrence of the forests. It undoubtedly plays an important part in confining the forest growth to these well defined areas, as the *cañadas* and *esteros* are so frequently burned over that no perennial vegetation can remain established.

A perusal of the literature pertaining to the quebracho region of Argentina does not reveal the existence of any attempt to classify the wooded areas to be found therein. In the absence of such forest classification it is believed that the following will prove to be of interest. With full recognition of its limitations, the writer has found it to be adaptable and of material aid in forest work in this region.

The forest, *monte*, of the quebracho region is divided into five distinct classes, each based in part on its botanical composition but more on its utility for exploitation purposes. These five classes are as follows: (1) *Monte virgen*, or virgin forest; (2) *Monte bueno*, good forest, which may be either (*a*) *Monte ralero*, open forest, or (*b*) *Monte espeso*, thick forest; (3) *Monte de palma*, palm forest; (4) *Monte quemado*, burned forest; (5) *Monte exploitado*, cut-over forest.

Monte Virgen

The virgin forest, which is scarce in the southern half of the region, forms about eighty per cent of the forest in the northern half. The little that remains in the southern half is to be found only in small, scattered and isolated patches.

Table IV indicates the production of wood from a virgin stand of quebracho. The data are based on measurements taken on several sample plots of this class of forest, each plot being half a hectare (1.23 acres) in area. The figures given must of course be considered as representative and approximate.

Other tree species are usually found associated with quebracho in this class of forest. Algarrobo negro, algarrobo blanco, guayacan, tala, espina corona, guaranina, and molle are the most abundant.

Virgin forests of quebracho produce from 40,000 to 80,000 tons of quebracho wood per square league (=25 square kilometers, or 2500 hectares) and greater yields per square league have been secured. Although *monte virgen* contains a greater wood volume than any other class of forest to be found in the region, its present value is more determined by its location and accessibility with reference to existing railroad lines than by its wood content.

Monte Bueno

The good forest described as *monte bueno* produces from 25,000 to 40,000 tons of quebracho heartwood per league. This class of forest may have been exploited at one time previously, but on account of its present yield of wood it is classed as above. The data in Table V, based on several sample plot observations and measurements, concern such areas of forest.

Quebracho being primarily desired for the manufacture of extract, the wood content and value of the forest are always considered from this standpoint first. A forest area may be rich in new growth, but its trees being small in size (less than 200 kilos in weight) are usable only for posts and poles. A heartwood log is required to weigh 200 kilos or more to be of economic size for factory use. As a rule the wood volume of a forest classi-

TABLE IV—PRODUCTION OF WOOD FROM A VIRGIN STAND OF QUEBRACHO*

TYPES		PER HECTARE	PER SQUARE LEAGUE
Heartwood for extract, metric tons	Export	11.7	29,300
	Factory	5.1	12,800
Railroad ties, number		34	85,000
Large posts (enteros), number		22	55,000
Small posts (medios), number		36	90,000
Poles, number		24	60,000
Firewood (*leña campana*), metric tons		3.3	8,200
Guaranina, cubic feet		60	150,000

TABLE V—PRODUCTION OF WOOD FROM A GOOD FOREST OF QUEBRACHO*

TYPES		PER HECTARE	PER SQUARE LEAGUE
Heartwood for extract, metric tons	Export	7.3	18,300
	Factory	6.7	16,700
Railroad ties, number		26	65,000
Large posts (enteros), number		30	75,000
Small posts (medios), number		42	105,000
Firewood (*leña campana*), metric tons		0.4	10,000
Quebracho blanco, cubic feet		14	35,000
Guaranina, cubic feet		36	90,000

*The data in these tables were secured and compiled by the writer in the quebracho region of Argentina.

No tree below 200 kilos in weight was accepted as merchantable for extract purposes.

Export type logs include those cut from sound healthy trees of quebracho, free from counter curves and other undesirable forms and defects.

Factory type logs include those cut from trees of quebracho acceptable for factory use but that fail to satisfy the requirements for export material.

Railroad ties, posts, and poles in general refer to the heartwood of green quebracho, straight and sound.

Railroad ties were tallied in 2.4 meter lengths, this being considered as an average length tie. However, the estimates embrace ties of 1.8, 2.4, and 2.7 meters in length, allowing roughly one-third of the estimate for each class. A railroad tie is considered as being 12 x 24 centimeters in cross sectional dimension.

As to posts, enteros (whole posts) are 2.4 meters in length, 43 to 50 centimeters in circumference. Medios (small posts) are 2.2 meters in length, 34 to 42 centimeters in circumference. The estimates concerning each embrace from 1 to 2 per cent dead and standing material.

Poles refer to trees weighing less than 200 kilos and too large to be considered as posts, being for the most part trees 20 centimeters in diameter at the center point of the bole and 5 to 6 meters in length. The estimate embraces from 1 to 2 per cent dead and standing material.

Firewood refers to quebracho *leña campana* wood only, of dimensions 10 centimeters to 26 centimeters in diameter. *Leña campana* consists of dead and down quebracho wood from which the sapwood and bark have completely decayed.

fied as *monte bueno* is contained in a large number of trees per unit area, many of which are small in size. Additional species are also found in this class of forest, quebracho blanco being the most abundant and valuable.

This class of forest has two subdivisions that are worthy of note. *Monte ralero* is open forest, often resembling the parklike stands of the coniferous forests of the United States. It is characterized by the absence of underbrush and all understory vegetation except grass and minor herbaceous growth. It is thought that fire has brought about this condition, as the *ralero* is most abundant in the immediate vicinity of the *esteros* and *cañadas*, from which fire easily spreads into the edges of forest belts and patches. *Monte espeso* is a thick, closed stand of forest with a dense undergrowth of various herbaceous and treelike forms so interwoven one with another that passage without cutting one's way is next to impossible.

Monte de Palma

Palm forest, *Monte de palma*, is found for the most part in pure stands of from 10 to 20 trees to the acre; each tree 10 to 14 inches in diameter and from 60 to 70 feet in average height. These forests appear to be uniform in age, are open and parklike in formation, and are nearly always found on the border of the forest between the belts and patches of quebracho forest and the open *esteros* and *cañadas*. They are irregularly distributed, occurring only here and there as some peculiarity of the soil and water suits their requirements. Palma amarilla, palma negra corteza, and palma corazón are the three principal species of palm found in this class of forest. Because of their long straight and branchless trunks these trees are often cut and utilized as poles.

Monte Quemado

Monte quemado signifies burned forest. Reference has already been made to the serious destruction by fire wrought in this as in most other forest regions of the world.

From burned-over forest one class of wood only can be secured, namely, *leña campana*, or firewood. Through the associated action of fire and decay the bark and sapwood of the quebracho tree disappear, leaving the solid, weathered, and often charred heartwood. Wood of this character is undesirable for extract purposes but has a high heating value and is the best and most economical firewood obtainable in Argentina.

The approximate amount of firewood available on a burned *monte* is 3.4 metric tons per hectare, or 8500 tons per league. Obviously the amount of firewood available on burned-over areas is directly proportional to the severity of the fire. However, the fire usually passes through the forest killing the trees and other vegetation but leaving them standing in a dead charred mass. It is through the salvaging of such areas that firewood is secured.

Burned-over forest is usually exploited on contracts known as firewood exploitation rights (*derecho de leña*). These are taken up by a number of small capitalists who do not own land. They contract to remove the wood in small amounts for various purposes and do so according to the demand of the moment. *Derecho de monte*, which concerns small contracts for the exploitation of the forest proper for quebracho wood, is issued in this manner also.

Charcoal is cheaper to transport than wood and hence can be shipped farther at an equal cost. It is manufactured in the forest within easy reach of the railroads, especially in the burns which adjoin *monte ralero*, *esteros*, and *cañadas*, as through these, when dry, no roads need be built for hauling the charcoal to the railroad.

Monte Exploitado

A completely cut-over forest is classed as *monte exploitado*. Often *quebracho nuevo*, young growth or reproduction, which at the time is too small for use even as *estacones*, small stakes, is left and later develops into profitable quebracho forest. Near railroads all *montes* are well cut out of everything saleable or usable. The degree and intensity of the exploitation decreases with an increase in distance from the railroads, for the cost of transportation is the factor deciding the extent of such exploitation.

THE ECONOMIC FUNCTION OF THE RHINE

By JACQUES LEVAINVILLE

In the United States, river navigation, especially on the Mississippi, on the Missouri, and on the Ohio, has been unable to compete with the railroads. The railroad rates in America are lower than the river and canal rates. In Europe, where transportation problems are dissimilar in many respects, the waterways compete favorably with the railroads and are likely to continue to do so. A reduction in railroad tariffs does not seem likely for a long time. On the contrary, the cost of upkeep of the railroads and the demands of the employees are constantly increasing; additional increments of expense must be expected. To the extent that the railroads will find themselves obliged to increase their rates, their indisputable advantages (speed and flexibility) will decline and will be offset by the advantages of the water routes (large barge capacity, power of the port machinery, cheapness of transportation in bulk).

From the standpoint of economic geography the rivers prolong the great ocean routes into the interior of the lands. Of the "flowing roads" the Rhine is one of the most remarkable. It leads from the ocean into the very heart of the continent.[1]

Freedom of river communication was one of the fundamental principles of the French Revolution: "No nation can without injustice claim the right to occupy the channel of a river to the exclusion of others and to prevent the neighboring peoples who inhabit the banks of its upper course from enjoying the same privilege as they. This pretended right is a remainder of feudal servitude or at least a hateful monopoly which could only have been established by force and acquiesced in through weakness" (*Moniteur* No. 317, of November 22, 1792).

Article 5 of the First Treaty of Paris, 1814, which ended the wars of the Empire, put forth the following declaration: "The navigation of the Rhine, from the point where it becomes navigable to the sea, and vice versa,

[1] Among post-war publications consult principally: Gaston Haelling: Le Rhin: politique, économique, commercial, Paris, 1921; Emmanuel de Martonne: Conditions physiques et économiques de la navigation rhénane, Paris, 1921; A. Antoine: L'aménagement du Rhin de Bâle à Strasbourg, Paris, 1922; P. H. Schmidt: Der freie Rhein und der Wiederaufbau Europas, *Nordostschweizerischer Verband für die Schiffahrt Rhein-Bodensee Verbandsschrift Nr. 35*, St. Gall, 1921 (also in French as "Le Rhin libre et la reconstitution de l'Europe," Paris, 1922).

Among earlier publications, the following are useful: (1) Der Rheinstrom und seine wichtigsten Nebenflüsse von den Quellen bis zum Austritt des Stromes aus dem Deutschen Reich: Eine hydrographische, wasserwirtschaftliche und wasserrechtliche Darstellung, mit vorzugsweise eingehender Behandlung des Deutschen Stromgebietes. Im Auftrag der Reichskommission zur Untersuchung der Rheinstromverhältnisse herausgegeben von dem Centralbureau für Meteorologie und Hydrographie im Grossherzogthum Baden. Berlin, 1889. With an atlas of 22 plates containing general maps, 1 : 2,000,000, of the Rhine basin exclusive of Holland, showing topography, geology, hydrography, rainfall, forests, territorial divisions; a profile of the Rhine and its main tributaries; a diagram of areas subject to flood; and a detailed map in 1 : 100,000 in 17 sheets of the Rhine from Constance to the German-Dutch border. (2) E. J. Clapp: The Navigable Rhine: The Development of Its Shipping, the Basis of the Prosperity of Its Commerce and Its Traffic in 1907, Boston, 1911, with bibliography.

shall be free, in that it can be forbidden to no one." For the first time the Rhine ceased to signify a military boundary; the river was no longer exclusively a symbol of war; the economic power of the river as a transporting vehicle was recognized.

The Treaty of Versailles has again recognized these principles. The

FIG. 1—Map showing the economic resources tributary to, and the waterways connecting with, the Rhine. Scale, 1:6,800,000.

Rhine is a European and even a world problem. Free navigation on it is of importance not only to the riparian states but also to nations distant from its banks. The power of the river is felt far beyond the geographical limits of its basin. The international commission which regulates the economic life of the river is therefore justly composed not only of the representatives of the riparian states—the Netherlands, Germany, France, Switzerland—

but also of representatives of more distant states, whose interests at first thought seem less immediate—Belgium, Italy, Great Britain (Article 355 of the Treaty of Versailles).

The Geographical Conditions

The Economic Resources of the Rhine Region[2]

The developed resources of the region traversed by the river would alone assure an important activity to the waterway. This region is first and foremost a mining area (Fig. 1).

The discovery of the potash of Nonnenbruch in Upper Alsace was made, it will be remembered, in the course of a search for petroleum; the deposits amount to 300,000,000 tons, marketable without further treatment (world consumption amounted to 1,000,000 tons in 1913). Only the deposits of Catalonia and of Stassfurt are more important. Because of the dominating position of the latter the Alsatian deposits produced only 350,000 tons in 1913, but production surpassed 1,100,000 tons in 1920. It is estimated that they will be able to furnish 3,000,000 tons annually. The Alsatian potash, which does not contain magnesium, is particularly in demand in England and the United States. It will furnish an important return-freight commodity for the coal barges which ascend the Rhine to Strasbourg.

But it is rather fuels that constitute the most important part of the economic resources of the Rhine region.

The petroleum of Pechelbronn, to be sure, affects the river traffic only in a small way. The annual production hardly amounts to more than 75,000 tons of oil, and consumption is entirely local. On the other hand, the lignite of the Aachen basin and the coals of the Ruhr furnish the greater part of the river freight. The Rhine is a coal river.

The lignite basin of Cologne extends from the Rhine to the Erft, a left tributary of the Rhine, with a maximum width of 12 kilometers and maximum length of 60 kilometers. Two other small deposits lie in the latitude of Bonn to the west of the Erft and on the right bank of the Rhine opposite Cologne. The reserves are estimated to be 3,000,000,000 tons. The mines are open-pit mines. The workable seam is from 15 to 100 meters thick. In 1913, 3,629,000 tons were shipped by railroad and 667,000 tons by way of the Rhine after having been loaded at the port of Wesserling. The dearth of mineral fuels gives these lignite deposits an importance of the first rank. In 1913 the production of Germany was 87,000,000 tons of lignite as against 191,000,000 tons of coal. In 1922 the production was 134,000,000 tons of lignite as against 129,000,000 tons of coal. The lignite syndicate of Cologne is preparing to increase production. It has acquired

[2] Some of the data are conveniently accessible in "World Atlas of Commercial Geology, Part I: Distribution of Mineral Production," U. S. Geol. Survey, Washington, D. C., 1921.

a Rhine fleet which includes tugboats of a total of 5450 h. p. and barges of a total of 38,448 tons.

While this increase of activity is in the future, it is coal that at present constitutes the principal Rhine cargo. Of 54,000,000 tons transported in 1913, 22,000,000 came from Westphalia. Even so, this tonnage represents only one-seventh of the production; the rest was consumed locally by the large number of metallurgical establishments.

The reserves of the Rhine coal fields were estimated as 200,000,000,000 tons by the International Geological Congress in Canada, 1913, the French reserves being estimated as less than 20,000,000,000 tons.

The current of coal emanating from the Duisburg region ramifies on entering the canals and navigable rivers. It follows the Dortmund-Ems Canal; by means of the Rhine it reaches Holland, where it meets English coal, and Belgium, whither it goes in spite of Belgian collieries and English coal. To the south it goes up the Main as far as Würzburg and up the Neckar as far as Heilbronn; it reaches Switzerland and Italy after having been transferred at Mannheim to the railway. In France it ascends the Marne-Rhine Canal, where it meets the coal from the Saar. The importance of this current gives Germany a privileged position. It is true that English coals have been put on the market at Mannheim, at Strasbourg, and at Stuttgart; but these are special kinds which are suitable for a specific purpose, such as the making of gas, for instance, or they are shipments which are due to exceptional circumstances, such as strikes or shortage of fuel.

The magnitude of the coal resources led at an early period to the development of small metallurgical centers. The Lahn and the Siegen districts produced the necessary iron ore. But these resources soon became insufficient, and the metallurgical industries of the Rhine region, therefore, had to turn principally to foreign countries for their supply.

In 1913 the Zollverein (Germany and Luxemburg) produced 19,300,000 tons of pig iron with 35,911,000 tons of domestic ore and 14,000,000 tons of imported ore; of this total the domestic ore, with its 31.8 per cent of iron, could produce only 10,500,000 tons of pig iron. There remained therefore about 9,000,000 tons, or 46 per cent of the production, which were produced by means of the foreign ores, or 80 per cent if in this category be counted 8,600,000 tons of metal obtained in the Saar and in Westphalia by the fusion of the minette ores imported from Lorraine and Luxemburg. In 1913 the imported ores to the total value of 14,028,000 tons came from the following countries and in the following amounts in metric tons: Sweden, 4,558,000; France, 3,811,000; Spain, 3,651,000; Russia, 489,000; Belgium, 127,000; Austria-Hungary, 106,000; Algeria and Tunis, 607,000; Greece, 147,000; other countries, 532,000. Of this total the African and Spanish ores and the greater part of the Swedish ore, together 7,000,000 tons, came by way of the Rhine. On the other hand, the Lorraine ores were transported by railroad: hostility of the German government to the canalization of the Moselle prevented the Rhine from carrying this remunerative cargo.

As a consequence of the importance of these mineral resources the Rhine region has always been one of the most densely populated regions of Europe. From Alsace to Holland there is all along the river a density of population three times that of the average in France (75 inhabitants to the square kilometer). At every 30 kilometers, on the average, a city of 100,000 inhabitants is met with on the banks or in the immediate vicinity of the Rhine. That is the origin of the third element of the commercial movement, namely the cereals.

This current has increased parallel to the growth of population from 1900 to 1912, but it has remained an import current directed almost exclusively upstream. It grows weaker from north to south; nevertheless it still reaches Strasbourg. The very weak downstream movement is due particularly to the reshipment of flour. The cereals come from Russia, Rumania, the United States, and Argentina. The share of Russia was before the war the largest (40 per cent); then came Rumania, the United States, and Argentina. The sources of the current are in the Belgian and Dutch ports.

The fuels, the ores, and the cereals constitute four-fifths of the Rhine freight. These are heavy commodities. They naturally prefer the water to the rail route. Their places of origin and their destination show that to transport them concerns not only the riparian states, which use or transform these commodities, but also more distant countries, through which they pass in transit or from which they are shipped.

The Economic Zone of the Rhine

Among the riparian states Belgium and Holland occupy a position by themselves. Traffic between the Rhine and the group of three ports, Amsterdam, Rotterdam, and Antwerp, in 1913 amounted to 14,000,000 tons from the Rhine and 18,000,000 tons to the Rhine. The most important elements of this traffic are coal (9,000,000 tons), iron ore (8,000,000 tons), and cereals (4,000,000 tons). The Belgian ports dispatched 8,000,000 tons by way of the Rhine in 1912, more than the tonnage of Mannheim and Ludwigshafen combined.

"In the Rhine fleet," writes Emmanuel de Martonne, "the Netherlands and Belgium hold an important place. Of 1671 steamboats 748, or 45 per cent, were German; 711, or 43 per cent, were Dutch; 212, or 12 per cent, were Belgian. Through the great coal port of Duisburg pass almost as many Dutch boats (22,597) as German boats (27,075). . . . At Cologne there are still 1742 Dutch boats and 1007 Belgian boats. Even at Strasbourg 276 Dutch boats and 122 Belgian boats were noted in 1912."

To Switzerland the importance of the river is not less. For Switzerland the Rhine is the only free outlet towards the ocean, the only route by which it can secure the indispensable raw materials for its industries, whose development has been especially rapid but whose future is uncertain because of geographical conditions. The economic future of Switzerland is

dependent on Westphalian coal. Of a total of imported coal covering the period 1908–1912 at an annual value of 83,000,000 francs, Germany contributed 71,000,000 francs' worth. The remaining 12,000,000 francs' worth probably is coal in transit and consists of a certain amount of German coal. It is the same with iron and steel (101,000,000 francs contributed by Germany out of a total of 124,000,000 francs' worth). The organization of river transport is also responsible for the German preponderance on the Swiss market, in wool (53,000,000 francs out of a total of 73,000,000), in cotton (20,000,000 francs out of 42,000,000), and even in cereals (19,000,000 francs out of 23,000,000). Before the war the transportation of a ton of cereals cost 21.50 francs from Rotterdam to Berne as against 25.10 francs from Genoa to Berne. Of the total Swiss imports Germany furnishes one-third, of its exports it takes 22 per cent.

Except for Belgium and Holland, Rhine delta countries, and Switzerland, a country at the source of the river, it is difficult to estimate the share of foreign countries which use the Rhine for traffic or transit.

From the Rhine Italy receives coal and worked metals. To the Rhine she sends silks and cereals.

England has more evident interests. The tonnage of maritime navigation with the English ports was 68,000 in 1912. A regular steamboat service exists between Cologne and London; there is also traffic between the Rhine countries and England by way of Antwerp and Rotterdam as intermediaries. The imports of 1922 are more than those of 1913. Later the Rhine will be the natural route for the exchange of the Lorraine ores against the coking coals of England.

Finally, the United States through its cereals, petroleum, and cotton, Russia and Rumania through their petroleum and cereals, are also interested in the problems of the Rhine.

The number and diversity of the customers, the importance and weight of the transported products, more than their value, explain why the traffic of the Rhine ports rose from 25,000,000 tons in 1890 to 110,000,000 tons in 1921, i. e. twice as much as the traffic of all the rivers and canals in France during the same period.

The Rhine Ports: the River-mouth Ports

The distribution of this traffic is especially interesting. "All the Rhine ports," writes M. Gaston Haelling, "are preëminently transit ports. On the one hand, the merchandise leaves the ocean routes to change to the river route—this is the rôle of the river-mouth ports, of which Antwerp and Rotterdam are the chief; or the merchandise is transshipped to go to other ports—this is the rôle of the export ports, of which Duisburg, Ruhrort, and Cologne are the principal ones; or the merchandise is unloaded in order to continue by river route or by railroad—this is the rôle of Mannheim-Rheinau-Ludwigshafen and of Strasbourg."

Rotterdam is the only river-mouth port directly on the Rhine route. Amsterdam can be reached only by the Merwede Canal, and the passage from Antwerp to the Rhine involves the difficult crossing of Zeeland. Furthermore, while at Antwerp or at Amsterdam the direct transfer of the cargo to the barge is made only from one side of the ship, at Rotterdam it takes place simultaneously from both sides of the vessel, which is anchored in mid stream, moored to buoys or to bollards. Owing to these more advantageous arrangements Rotterdam gets the greater part of the ocean traffic destined for the Rhine. In 1913, of 14,000,000 tons going down the Rhine 7,000,000 passed through Rotterdam, and of 18,000,000 tons going up the river 15,000,000 passed through this port.

Antwerp, on the other hand, owing to the excellent network of railways which covers Belgium, is a railroad port. For this reason the Belgian ports exported only 2,900,000 tons in 1913 and imported 6,100,000 tons, principally of coal, because of the abundance of ocean tonnage used in the export trade. The excellence of the railway network limits the development of navigation at Antwerp while the really inferior arrangements of the Dutch railroads favors Rotterdam as a port. Thus Rotterdam in 1913 dispatched 131,435 tons of sugar to the Rhine while Antwerp shipped only 273 tons by the same route, not because Antwerp did not ship any sugar, but because this very expensive staple cannot stand transportation charges by rail.

As for Amsterdam, its relations with Cologne date from the period when the greater part of European traffic passed through this port. At present the difficulties of navigation in the Merwede Canal have considerably reduced this traffic. The figures for 1913 indicate only 475,000 tons coming from the Rhine and 556,000 tons going to the Rhine.

The Import Ports

The group of three ports, Mannheim-Rheinau-Ludwigshafen, owes its phenomenal development to its situation at the best point of transshipment between the sea on the one hand and South Germany and Switzerland on the other hand. Also, until recently, this nucleus was the terminus of upstream navigation. Since then Strasbourg, as is known, has assumed this rôle.[3]

Nevertheless Mannheim-Rheinau-Ludwigshafen retain all their economic importance for the exploitation of the southern markets. Indeed, even if Bavaria forms a part of the hydrographic system of the Danube, the great length of this river and its relatively poor navigability in Bavaria tie this country to the hydrographic system of the North Sea. Munich is 400 kilometers from Cassel, the terminus of navigation on the Weser, and 300 kilometers from Prague, the terminus of navigation on the Vltava (Moldau), a tributary of the Elbe. However, these places could only be reached after

[3] See the author's paper, "The Port of Strasbourg," *Geogr. Rev.*, Vol. 13, 1923, pp. 243–254.

the difficult crossing respectively of the Swabian Jura and the Bohemian Forest.

In 1913 for all three ports the traffic amounted to 8,500,000 tons incoming and 1,600,000 tons outgoing. Coal, coke, and briquettes accounted for 3,500,000 tons for Mannheim and Rheinau and 815,000 tons for Ludwigshafen. Next in amount came the cereals, 1,300,000 tons. Fuel and cereals constituted three-fourths of the incoming traffic. The remainder consisted principally of cement, iron, and steel.

Finally, attention should again be called to the considerable rôle of these three ports in the traffic of Strasbourg, which at low water is accessible for the large barges only after they have lightened a part of their cargo.

The Export Ports

The creation and expansion of the Westphalian ports are closely related to the exploitation of the coal mines. In the open lowlands of the river the dredging of large basins was easy. The basins of Ruhrort on the right bank are no less than 128 hectares in area, with 28 kilometers of docks; those of Duisburg are 42 hectares in area, with 11 kilometers of docks. These river facilities have been supplemented by the Herne Canal. It is 38 kilometers long and traverses the coal basin; 13 industrial ports discharge into it. In addition, forming part of the same group, industrial ports have developed along the Rhine. These are Rheinhausen with the Krupp factories, Homberg with the Rhein-Preussen syndicate, Alsum and Schwelgern with the Thyssen plant, and Walsum with the Gutehoffnungshütte.

The complex of these ports shipped 22,000,000 tons of coal in 1912 and received 9,000,000 tons of ore and 1,640,000 tons of earth and sand. For the nourishment of the mining population of the region these ports imported more than 1,000,000 tons of cereals. The general traffic movement reached 39,000,000 tons in 1913, thereby exceeding that of the great European ports, including London and Hamburg.

The Waterways

The Rhine

Conditions so favorable would have stimulated the development of navigation even in spite of natural obstacles. However, the Rhine is one of the rivers most favored by nature for navigation. Table I, taken from the work by Haelling, gives the principal elements of its course.

The greatest difference between the Rhine from Basel to Strasbourg and the Rhine below Strasbourg is the heavy gradient in the upstream stretch, which causes a very swift current. The mean gradient between Basel and Strasbourg is 86 centimeters per kilometer, and in the upper part of this stretch it exceeds one meter per kilometer, while in the stretch Strasbourg-Mannheim it is only 35 centimeters per kilometer (Fig 2). In addition, the improvements made below Strasbourg have increased the gradient

above that point. In the establishment of the profile of equilibrium of the river, its channel, meandering across the sands and gravels, the product of its erosion, is not fixed; furthermore, a rock ledge near Istein forms a veritable rapid. In certain places the depth of 2 meters necessary for navigation is maintained only during 45 days. Finally the average rapidity of the current in this stretch exceeds 10 kilometers an hour. As a consequence of these factors the duration of navigation is very short; a tug can haul only two barges of 5000 tons each. Traffic, therefore, is slight between Basel and Strasbourg; even in favorable years it does not amount to as much as 100,000 tons.

TABLE I—THE RHINE: ELEMENTS IN ITS NAVIGATION

PORTS	DISTANCE IN KILOMETERS	ALTITUDE IN METERS	AVERAGE WIDTH IN METERS	AVERAGE GRADIENT
Basel	0	243.5	200	1:1000
Strasbourg . . .	127	131.6	220	1:1600
Ludwigshafen . .	181	85.1	260	1:9000
Mainz	331	80.4	430	1:10,000
Bingen	361	76.1	250	1:2000
Coblenz	424	57.6	260	1:4000
Cologne	520	35.9	360	1:5000
Duisburg	613	20.1	380	1:5500
Rotterdam . . .	830		500	1:8000
North Sea . . .	860		700	

But below Strasbourg the gradient is slight and nowhere over 5 per 1000 except in the crossing of the Slate Mountains between Bingen and Bonn, where beds of quartzite cross the river and create rapids. These obstacles were removed by improvements carried out before the war. The "wilde Gefahr" of Caub is only a memory. On the other hand, the regimen of the river is very constant. The volume of water is maintained in winter by tributaries of Sequanian type (i. e. maximum volume in winter, like the Seine) and in summer by tributaries of Alpine type (maximum volume in summer).

For these reasons, navigation is very rarely interrupted on account of low water: in 1912, 9 days at Strasbourg, 6 at Mannheim, 72 at Mainz, 22 at Cologne, 16 at Emmerich. Frost has still less importance: it occurs when navigation is stopped during the low water of winter.

As a matter of fact the river, constantly being improved, has permitted regular service except for rare occasions by means of vessels of 2000 to 2500 tons between Ruhrort and Rotterdam, of 1700 to 2000 tons between Ruhrort and Mannheim, and of 1700 to 800 tons between Mannheim and Strasbourg.

The largest boat in service on the Rhine has the following measurements: length, 123 meters; width, 14 meters; draft, 2.85 meters; tonnage, 3581 tons.

Finally, the Rhine empties into a tributary sea of the Atlantic Ocean which lies at the beginning of the largest current of world commerce. This is a privileged situation as compared with the other rivers of Europe. The Danube, for instance, empties into a sea which communicates only with difficulty with the Mediterranean.

These advantages of Rhine navigation have not escaped the nations which profit by it. All have sought for easy accesses to the Rhine, i. e.

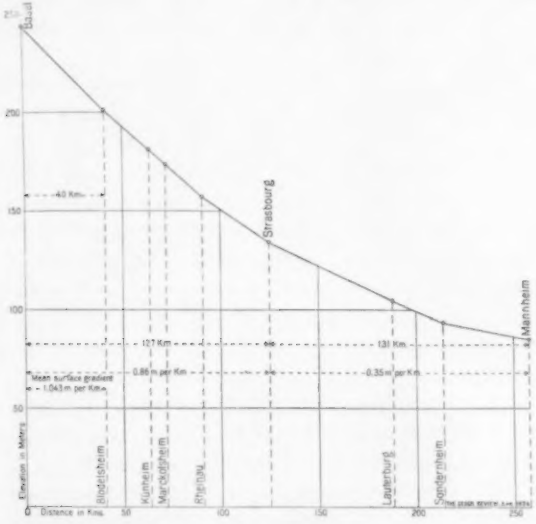

FIG. 2—Graph showing the mean surface gradient of the Rhine between Basel and Strasbourg. Based on the work by G. Haelling cited in footnote 1.

toward the sea. From this has resulted the competition among the various schemes of river and canal connections with the great river.

THE CANALS: CONNECTIONS WITH THE RIVER MOUTH

The central Alps give birth to three great rivers, the Danube, the Rhine, the Rhone. All three leave this common center of dispersal to reach different seas: the Black, the North Sea, and the Western Mediterranean. It is only necessary to unite these seas in order to create two uninterrupted routes going around the Alps, the one on the east and the other on the west, which shall put into communication the two great centers of European civilization, the Mediterranean and the northern seas.[4]

[4] For the canals consult Sympher: Karte der deutschen Wasserstrassen unter besonderer Berücksichtigung der Tiefen- und Schleusen-Verhältnisse, 1 : 800,000, 4th edit., Berlin, [1912?]; Carte itinéraire des voies navigables de France, 1 : 1,500,000, Ministère des Travaux Publics, Paris.

These complex relations begin at the mouth of the Rhine. For this reason the Treaty of Versailles wisely took into account the connections with ocean ports. At Pannerden immediately on its entry into Holland the great river divides into several branches which interlace with those of the Meuse. At present they are held between dikes, and the distribution of the run-off is regulated by conventions which go back to the eighteenth century. Old arms, whose width sometimes attains 100 meters, can easily be changed into canals. Also, in the great alluvial plain formed by the Meuse and Scheldt it is easy to establish connections. Amsterdam was connected with the Rhine and the Meuse by the Merwede Canal. At Antwerp starts the Scheldt-Meuse Canal, which near the Dutch-Belgian boundary joins the Zuid Willem's Canal.

Nevertheless, communication between Belgium and the Rhine is difficult. In order to increase the traffic in Ruhr coal the Treaty of Versailles has provided (Article 361) for a water route which would go directly to Ruhrort. At present the passage from Antwerp to the Rhine is 330 kilometers long. The Hentricht project, which dates from 1909 and takes up again the route proposed by Napoleon, is 185 kilometers long; it would serve the coal districts of Campine and end at Ruhrort. The Valentin project would cross the Meuse at Maastricht and end at Düsseldorf and would be 235 kilometers long. The Schneider project would cross the Meuse below Maastricht, serve the Liége industrial region, and end at Bonn and would be 320 kilometers long.

It is difficult to estimate a date at which one of these projects will be completed, but opinion is unanimous that it is necessary soon to establish a connection between Antwerp and Moerdijk (at the mouth of the Meuse) by means of an artificial channel to avoid going across Zeeland. This canal would reduce by a half the passage Antwerp-Moerdijk. It would avoid the long and dangerous passage between the islands of Zeeland, where storms are frequent.

Ruhr Canals

Belgium and Holland control the mouths of the Rhine. It is to escape this control to a certain extent that the canals between the Rhine, the Ems, and the Weser were built.

The Lippe is the principal river which drains the Ruhr district. It is canalized up to Hamm with a depth of 2.50 meters. It is connected with the Ems and the canalized Emscher by the Dortmund-Ems Canal, which was built in 1892–1899. This canal is connected with the Dutch canals about 100 kilometers south of Emden and by means of the Ems-Jade Canal with the Weser.

The Dortmund-Ems Canal is joined at Bevergern by the Herne Canal, 44 kilometers long, a section of the great Mittelland Canal which is to establish a connection between the Rhine and the Oder. At present this canal cuts the Weser at Minden and goes as far as Hanover; it is to be con-

tinued to Magdeburg and Berlin. It will make it possible for the Ruhr coal to compete in the capital of Prussia with English coal discharged at Hamburg. In 1920 the traffic of the Herne Canal amounted to 8,500,000 tons.

At present the length of the water route between Gelsenkirchen and Hamburg is 725 kilometers and between Gelsenkirchen and Bremen 280 kilometers. These distances are much too long for heavy freight. For this reason a series of canals has been projected starting from the Mittelland Canal to join the Elbe near Hamburg. But the realization of these projects may be delayed by the financial situation of Germany.

The Canalized Moselle

Westphalia in 1913 used 25,000,000 tons of Lorraine iron ore, all of which had come by rail. If the Moselle were canalized this traffic could be carried by water, with all the greater advantage because the necessary coke for the Lorraine furnaces would be carried on the return trip.

To be sure, the volume of water is not sufficient to clear away the sands that are deposited between Metz and Coblenz. The regularization of the channel is difficult, but it would be possible to turn the Moselle into a canalized river with dams and locks. A part of the expenses could be recovered by electric plants constructed along the river. Before the war projects of this nature had been studied by the German administration. It was the Westphalian industrialists who opposed these measures. Indeed, the canalization of the Moselle would have made possible cheap transportation of the coking coals and would have worked to the advantage of the Lorraine furnaces, which are situated on the ore field.

In order to favor the Ruhr industrialists the administration lowered the shipping charges by rail for Lorraine ores without correspondingly reducing the rate for coal shipped in the opposite direction.

The Rhine-Danube Connection

The connections between the Rhine and the Danube have as their object the service of the needs of South Germany and the economic conquest of the Balkan countries. It is a part of the program of Germany's orientation toward the East. The canals which, in addition to the existing connection, are to join the Rhine with the Danube are only a part of the great water route which is to connect the Black Sea with the coal basins of the Ruhr. It is at Duisburg that the cereals from the Balkans and from Hungary, the wheat and petroleum of Rumania, the wood and the ores from Central Europe are to reach their destination; it is from Duisburg that the Ruhr steel will leave to flood southeastern Europe, the shores of the Black Sea, and, beyond, the Near East. What the Bagdad Railway, stopped in its development by the war, has not been able to do, it is hoped the Rhine-Danube Canal will realize. Several projects are under consideration (Fig. 1).

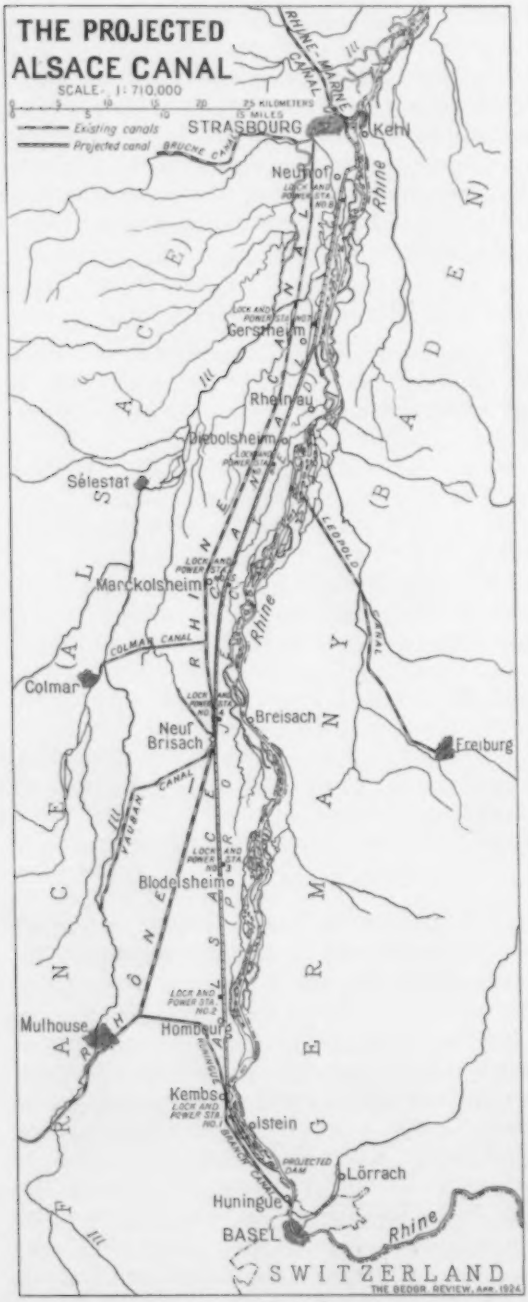

FIG. 3—Map based on the work by A. Antoine cited in footnote 1.

The first[5] involves the canalization of the Neckar as far as Plochingen above Stuttgart, then the construction of a lock canal to reach the Danube at Ulm, with a branch by way of Gmünd, Aalen, and the valley of the Brenz. The canal is sure to receive the 3,700,000 tons traffic which now goes by rail over this route; it would cross rich and densely populated districts; it would exploit the iron ore deposits, the soft coals, and limestones of the Swabian Jura. But, because of the number of engineering works to be undertaken, its cost would be high. Also, not to displease Bavaria, the Reich has preferred the second project.

This project, which between Bamberg and the Danube more or less parallels the existing Ludwig Canal, involves extending the canalization of the Main from Aschaffenburg to Wernfeld, at the northern apex of the great bend below Würzburg. From there a canal will avoid the next great bend of the river, which it will

[5] A. Ehlgötz: Die Rhein-Neckar-Donau Verbindung. *Zeitschr. für Binnen-Schiffahrt*, 1920, pp. 253–256 and 277–280.

reach again and cross at Garstadt to rejoin it at Untereuerheim and leave it finally at Bischberg after a vertical rise of 122 meters. The canal will then continue to Bamberg, follow the valley of the Regnitz, and cross the divide at Hilpoltstein at an elevation of 405 meters. It will then follow the valley of the Schwarzach, a small tributary of the Altmühl, and end in the improved Ludwig Canal. The total length of this proposed water route from Aschaffenburg to the Austrian boundary would amount to 607 kilometers, on which there would be 49 locks. It would cross the richest districts of Bavaria; its annual traffic is estimated at 10,000,000 tons; the electric power furnished by the locks is estimated at 1,000,000,000 kilowatt hours.

The Danube would be canalized from the entry into it of the canal at Kelheim to Ulm, the Lech as far as Augsburg; Munich would have a transfer port at Ingolstadt until the canalization of the Isar can be carried out. Finally, to insure a direct route to Switzerland, Germany projects a canal from the Danube to Lake Constance by way of the valleys of the Riss and Schussen.

The Alsace Canal

This last project[6] has taken form particularly since France has established herself on the left bank of the Rhine (Fig 3).

Indeed, the uncertainty of the river channel between Basel and Strasbourg, its steep gradient, and the swiftness of the current have made it necessary definitely to discard the plans which involved the regularization of the Rhine in this stretch. This undertaking, indeed, would not pay. Switzerland imports from Germany, Belgium, and Holland about 4,400,000 tons per year. To these countries it sends only 350,000 tons. The most important part of its exports consists of expensive merchandise which prefers the rail route. Barges on the river would be deprived of return freight. The commercial combination is poor.

It is therefore in the lateral plains that the solution of the problem must be sought for. Now, the Rhine flows nearer the Black Forest than the Vosges. The plain of Baden, which is relatively narrow, is blocked by the massif of the Kaiserstuhl at Breisach and, farther upstream, by the Dinkelberg plateau near Istein. Connections with the river basins are difficult on this side.

It is entirely different on the Alsatian side. The Ill traverses the plain with less gradient than the Rhine. To the south its valley ends in a large threshold, the famous Gateway of Belfort, which affords an easy passage towards the basin of the Saône. The rampart of the Vosges likewise grows lower in the north, and the Saverne threshold here affords a natural gateway which has for centuries been used by international commerce. Alsace is a country of canals.

[6] Cf. especially A. Antoine, *op. cit.*

France has received the mandate by the Treaty of Versailles to make use of these geographical advantages. A large canal paralleling the Rhine will begin on the river at Huningue and will go down to Strasbourg. The number of locks will not exceed eight. In order to furnish this canal with water, a large dam will be constructed across the Rhine near Huningue.

The current will be much less rapid than in the Rhine and will not exceed the speed of a man afoot. Instead of becoming greater in time of flood, the current, will, on the contrary, decrease, inasmuch as the whole run-off of the Rhine will be discharged into the bed of the river by the dam, which will function as an immense safety valve. At every step of this gigantic stairway an important power plant will be established. The total of these plants will make it possible to recover 700,000 h. p. This power will be made available to the industrial establishments in Strasbourg, Mulhouse, and Basel. Switzerland, too, will benefit by the Alsace canal.

THE GEOGRAPHY OF THE MOSLEMS OF THE MIDDLE AGES

By Carl Schoy

Content of Arabic Geographical Science

The majority of Arabic geographical authors based their work more or less on the "Geography" of Claudius Ptolemy. This famous Greek man of science, however, was originally an astronomer and mathematician, a circumstance not without influence upon his geographical work. To appreciate this, one need but bear in mind Ptolemy's cartographic achievements, or his division of the earth's surface into zones reckoned on the basis of astronomy, investigations of a type far removed from the work of earlier Greek scholars, who laid emphasis rather upon the describing (γράφειν) of lands and peoples. It thus came about that after Ptolemy the term "geography" came to be employed among the Greeks to designate primarily the exact science of the form of the earth.[1]

Quite naturally only a very few Arabic geographers were able, as Ptolemy had been, to adopt both methods as their own, the mathematical and astronomic on the one hand, the statistical and descriptive on the other. There were, rather, two groups among those Arabic scholars who contributed at all to the progress of geography: the geographers who traveled and wrote descriptive works and the astronomers. To arrive, then, at a definitive estimate of the geographical contribution of the Moslems, one would be obliged to take into consideration both types of investigation as represented by these groups, a task which the present writer believes has never been accomplished. Indeed, it scarcely could be accomplished, for many an Arabic astronomical treatise still lies buried under the dust of Oriental manuscript collections waiting to be made available by the competent hand of some future scholar. But happily the Moslems possessed one man of science who in every respect measured up to the standard of the Alexandrian Ptolemy; and about this man, the unsurpassable Abū'l Rīḥan al-Bīrūnī (973–1048), we shall be able to speak in some detail.

According to circumstances the Moslems chose as a name for geography special designations from this or that branch of geographical study: they spoke of the "Science of Roads and Countries," the "Science of Post Routes," the "Science of Longitude and Latitude," the "Science of the Peculiarities of the *Climata*,"[2] etc. An Arabic scholar himself, Ḥajji Khalfa, who died in 1658, wrote as follows in a book entitled "Discussion of the Lore of the Names of Books and Sciences:"

[1] See the methodological and bibliographic introduction to this subject by Siegmund Günther in his "Handbuch der mathematischen Geographie," Stuttgart, 1890, p. 1.

[2] Belts running across the earth from east to west bounded by parallels of latitude.—Edit. Note.

"The Science of Geography (*jaghrāfīyā*). This is a Greek word meaning *description of the earth* (*ṣūrat al-arḍ*). It is a science through which we come to know the conditions of the seven *climata* which lie upon the inhabited quarter of the earth's surface: and besides this [it is the science] of the latitudes and longitudes of the lands which lie thereon, of the number of their cities, mountains, continents, seas, rivers, and of the other circumstances which exist upon this quarter of the earth. So it is defined in the book *Miftāḥ as-sa'āda* ("The Key of Fortune"). Sheikh Dā'ūd, however, says in his book *Tadhkira* ("Memoir") 'Geography is the science of the conditions of the [entire] earth, with reference to its division into *climata*, mountains, and rivers and of the conditions under which its inhabitants differ from one another.' This definition is the more correct, for geography deals not alone with the seven [*climata*]. Geography is a science designated by no special term in the Arabic language. The first who composed a book dealing with this science was Baṭlamyūs al-Qalauzī [Claudius Ptolemaeus]. After he had written the *Almagest* he compiled the book that is known under the title *Jaghrāfīyā*. . . . This became a standard work, consulted by every one who wrote any treatise on geography. But much that he had described fell into oblivion, his name and fame were misrepresented, and thus the gateway was closed against the uses to which one might have put his work. It was, [to be sure], translated into Arabic in the days of Ma'mūn, but at the present time this translation is not to be found."[3]

Conditions Particularly Favorable to Its Progress

The geographical horizon of the Arabs was greatly widened through the extremely rapid and victorious spread of Islam, although there had existed even in pre-Mohammedan days a certain measure of practical regional knowledge of the sort used by traders. Moslem generals were obliged as they advanced forward to collect all possible geographical data before carrying through their operations. Moreover, the central government needed descriptions of the importance, wealth, and extent of newly conquered cities and countries. According to Mas'ūdī, 'Omar, the Caliph, forwarded the following instructions in a letter to a certain man of learning: "Describe for me the lands of the earth, their climates and positions, and the influences which ground and climate exert upon their inhabitants."[4] Furthermore, the Arab conquerors for the most part found among the conquered folk a civilization far surpassing their own. They were thereby able to utilize established government postal services, well maintained roads, and registers of statistics and revenues; and the example supplied by these stimulated them in the organization of other enterprises, all of which were the products of a sort of practical geography. The language of the Koran, then as now

[3] Hans von Mžik: Ptolemaeus und die Karten der arabischen Geographen, *Mitt. K. K. Geogr. Gesell. in Wien*, Vol. 58, 1915, pp. 152–176; reference on pp. 156–157, footnote 7.

[4] C. Barbier de Meynard and Pavet de Courteille, edits.: Maçoudi, Les prairies d'or, text and French translation, 9 vols., Paris, 1861–1877; reference in Vol. 3, p. 123.

understood throughout the whole extent of the Moslem world, facilitated the journey of the Mecca pilgrim even from the farthest borderlands. According to Yāqūt, geography was a science pleasing in the eyes of God.[5] C. A. Nallino cites from Al-Ghazzālī's "Revival of the Knowledge of Religion" the following quotations illustrating this doctrine: "Whosoever goes forth from his own house in search of science will find himself until his return upon the road of God" and "for whosoever follows a highway in search of science God will render more easy the road to Paradise."[6]

Religious and astrological interests made it incumbent upon astronomers to lay particular stress upon the accurate determination of the geographical latitudes and longitudes of places. In the first place, the precise knowledge of latitudes was used in the construction of horizontal sundials (*basīṭa*), which, like town clocks, always adorned the open squares where prayers were said. Their lineation is entirely dependent upon the latitude of the town for which they were constructed. Moreover, these dials indicate the beginning and end of the noonday prayer (*'asr*) by the length of the shadow of the gnomon (*miqyās*), or rod. This length, however, is determined by the latitude and declination of the sun for each day.[7] Furthermore, the turning of the face toward Mecca during prayer (*qibla*) was governed by the geographical co-ordinates of Mecca and of the spot where the worshiper happened to be.[8] And finally, to cast a horoscope it was necessary to divide the heavens into twelve astrological mansions, the sizes of which were fixed by the time of year and by geographical latitude. There were reasons enough, therefore, why astronomers, who were at the same time servants of religion and readers of the stars, should wish to promote the science of the determination of geographical positions!

The Work of Travelers and Geographical Authors

Quite naturally, research and the work of translation in the West have been directed primarily to the writings of the travelers of Islam and of the geographers in the literal sense. Regional geography, hence, is the best-known aspect of Arabic geographical science. The wealth of source material, however, makes it well-nigh impossible to undertake a detailed consideration of this subject. Instead of this we can give only the following brief résumé.

The earliest Arabic geographer of repute was Muḥammad ibn Mūsā Al-Khwārizmī (died 850), who compiled a treatise entitled "Picture (Description) of the Earth" (*ṣūrat al-arḍ*) modeled closely after Ptolemy. The text accompanying the maps is extant but only in incomplete form. The

[5] C. Barbier de Meynard, edit.: Dictionnaire géographique, historique et littéraire de la Perse, Paris, 1861, p. vii.

[6] C. A. Nallino: Il valore metrico del grado di meridiano, Turin, 1893, p. 4.

[7] See Carl Schoy: Die Gnomonik der Araber, *Die Geschichte der Zeitmessung und der Uhren herausgegeben von Ernst von Bassermann-Jordan*, Vol. 1, Part F, Berlin, 1923, p. 44.

[8] See Carl Schoy: Über die Richtung der Qibla, *Sitzungsber. Bayerischen Akad. der Wiss., Math.-phys. Klasse*, Munich, 1922, pp. 55–68.

work as a whole, of which H. von Mžik gives a detailed analysis, is to be found in a single untranslated manuscript in Strasbourg.[9] In point of time there followed the official route book of Khordadhbeh, "Book of Routes and Provinces" (*Kitāb al-masālik w'al-mamālik*). Its author, an official in the central postal service at Surramanra'ā (Samarra) near Baghdad, was commissioned to undertake its compilation by the Caliph Al-Mo'tamid. The book contains accurate information about the stations, post relays, and revenues of each province. Aḥmed ibn Faḍlān was sent by the Caliph Al-Muqtadir in 921 as ambassador to the king of the Bulgars on the Volga. On his return he wrote a description of his journey.[10] Another notable geographer of this early Arabic period was Al-Maqdisī (the man of Jerusalem), who wandered through most countries of Islam, excepting Spain. In various capacities he acquired a fundamental knowledge of lands and peoples and, besides, made use of the experience and researches of his predecessors. His work, "On the Knowledge of the *Climata*," consequently presents a very valuable and full account of the Moslem world. Still another admirable treatise in the field of Arabic regional geography is the "Book of Sketches" (*Kitābal-ashkāl*) of Abū Zaid al-Balkhī (921), which underwent a first revision by Iṣṭakhrī under the title "The Routes of the Provinces" (*masālik al-mamālik*) and in turn was further revised and enlarged by Ibn Ḥauqal.[11] The sympathetic and often extremely exact understanding which the Arabic geographers had for everything foreign deserves much praise. They customarily took up in order one region after another, and one city after another, recording accurately the customs and habits of the inhabitants, something of their industrial life, and the products of the animal, vegetable, and mineral kingdoms. Besides this, they discussed every kind of superstition of which they could learn anything.[12]

As an illustration of the latter we have translated the following passage from Iṣṭakhrī dealing with ambergris.[13] "And *'anbar* (*ambra* is the Spanish form) occurs in Santarem, which lies on the encircling sea, and we have heard of no place on the Mediterranean nor on the encircling ocean other than Santarem where ambergris is found, though, to be sure, during my sojourn in Syria, a little of it appeared upon the shores of the Mediterranean. Every year there goes to Santarem a crawling beast which creeps on the stones of the coast, and from him the ambergris comes. The beast is a tailless quadruped, soft as silk: its color is that of gold from which it differs not at all and its skin is a costly treasure. The pelts are collected and made

[9] Hans von Mžik, *op. cit.*, pp. 159–165.

[10] See C. M. Fraehn: Ibn Fosslan und anderer arabischer Berichte über die Russen älterer Zeit, St. Petersburg, 1823.

[11] The famous Dutch Orientalist, M. J. De Goeje, has edited the text of this together with many other Arabic geographical texts in the Bibliotheca geographorum Arabicorum, in 6 volumes, Leiden, 1870–1894. See also De Goeje's Selections from Arabic Geographical Literature in R. J. H. Gottheil and Morris Jastrow's *Semitic Study Series*, No. 8, Leiden, 1907.

[12] See the description of the *ghūl*, or ghost of the desert, according to various Arabic geographers in Bernhard Moritz: Arabien: Studien zur physikalischen und historischen Geographie des Landes, Hanover, 1923, p. 8. Iṣṭakhrī branded this superstition as ridiculous.

[13] De Goeje, Bibliotheca, Part I, p. 42.

into garments which in the daytime display most varied colors, and the kings of the Omayad dynasty forbid (monopolize) their use. They are exported only in secret, a fact which raises the cost of the garments to some 1000 dinars because of their rarity and beauty."[14]

A most meritorious Arabic geographer was Masʿūdī (died 956), after Ibn Baṭūṭa the greatest traveler of the age. His travels are recorded in the "Meadows of Gold" (*Murūj adh-dhahab*)[15] and have been preserved. Like Iṣṭakhrī and Ibn Hauqal, he visited, among other parts of the world, the Volga region and corrected the ancient mistake that the Sea of Azov is connected with the Caspian, though, for all that, he argued that the Volga divides its waters, sending a branch to each sea. Masʿūdī also made a thoroughgoing study of geographical literature and worked into his writings many details from older works that have not been preserved.[16]

An altogether exceptionally prominent place among Moslem scholars was held by Al-Bīrūnī. His labors as mathematician, astronomer, and geographer were of uniformly excellent quality. At first in the service of the lord of Khiva, he later entered the employ of the two rulers of Ghazna in Afghanistan, Maḥmūd and Masʿūd. The high esteem which he enjoyed is proved by the statement of the former: "Science is so sublime that it cannot be surpassed. To it come all mortals, but it comes not to mortals." Al-Bīrūnī's devotion to learning was so unparalleled that it was said of him: "His hand scarcely ever left the scroll, nor his eyes ceased observing and his heart pondering except on the two days, Nairūz and Mihragān" (Persian holidays in spring and autumn). With his last patron Al-Bīrūnī went to India, learned the Indian tongue and sciences, and in exchange taught those of the Greeks. The fruit left for posterity of his Indian journeys and studies was the famous description of India,[17] a work which, by reason of Al-Bīrūnī's universal comprehension and profound knowledge of facts, may be regarded as the most significant Arabic production in the field of regional geography.

A geographical document, also of high importance, is the "Roger Book" (*Kitāb Rojēr*) of Idrīsī (1099–1164), a description of the earth with seventy maps compiled for King Roger II of Sicily. In this the seven *climata*, or geographical provinces, are set forth.[18]

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[14] See Hermann Ethé: Morgenländische Studien, Leipzig, 1870, p. 167–173; J. Ruska's article, Anbar, in *The Encyclopaedia of Islam*, Leiden and London, 1913, Vol. 1, p. 347; and finally the excellent dissertation of Fr. Storbeck: Die Berichte der arabischen Geographen des Mittelalters über Ostafrika (Zenj), Tübingen, 1912, pp. 67 ff.

[15] See above, footnote 4.

[16] See also his "Book of Admonishment and of the Revision" (*Kitāb al-tanbih w'al-ishrāf*), translated by Bernard Carra de Vaux into French, "Maçoudi: Le livre de l'avertissement et de la révision," Paris, 1897.

[17] Translated into English by Eduard Sachau under the title "Alberuni's India" (Trübner's Oriental Series), 2 vols., London, 1888.

[18] A complete, though insufficient, translation of the "Roger Book" was published by Amédée Jaubert: Géographie d'Édrisi, traduite de l'arabe en français, *Recueil de voyages et de mémoires publié par la Société de Géographie*, Vols. 5 and 6, Paris, 1836, 1840. We owe to R. Dozy and M. J. De Goeje a critical edition of the section dealing with Spain and Africa: Description de l'Afrique et de l'Espagne par Edrīsī, Leiden, 1866 (Arabic text with French translation and notes).

A geographical dictionary based upon valuable sources and numerous personal journeys was left for us by the scholar Yāqūt (1179–1229), a man upon whom life bestowed only poverty and hardships. As a boy Yāqūt became a prisoner and was bought as a slave by a merchant of Baghdad.[19] His dictionary is entitled "The Totality of Cities (Lands)" (*Mu'jam al-buldān*).[20]

The fame and works of Dimishqī,[21] Abū'l-Fidā',[22] and Ibn Baṭūṭa[23] are so well known that a mere mention of them must suffice.[24]

Arabic Cartography

One might expect that the Arabic scholars trained in astronomy would have taken over and developed the cartography whch Ptolemy bequeathed to them. This, however, was by no means the case. They contented themselves in their works on astronomical tables (*zījāt*) with a bald tabulation of cities and regions according to latitude and longitude.[25] At all events Al-Khwārizmī, whose "Kitāb ṣūrat al-arḍ" was assuredly nothing but the text accompanying his map of the world, took no heed of any grid of co-ordinates. His map, which exists at the present time only in incomplete form, was apparently copied from a Syrian copy of the world map of Ptolemy.[26]

Idrīsī's map of the world, of which the "Kitāb Rojēr" also seems to have formed an explanatory text, reveals an even further retrogression in Arabic cartography. Preserved in several specimens, it surprises the student by the care here and there revealed in its draftsmanship. Nevertheless, with Idrīsī all understanding of geographical co-ordinates had completely disappeared, and the same may be said of any understanding of scale. Iṣṭakhrī's map of Persia is likewise nothing but a rough sketch.

Recently Hans von Mžik has made known a seventeenth century Persian manuscript of the "Kitāb ṣūrat al-arḍ."[27] Of the maps which accompany

[19] Further details in regard to Yāqūt's life are to be found in Carl Brockelmann: Geschichte der arabischen Litteratur (2 vols., Weimar, 1897–1902), Vol. 1, pp. 479–480.

[20] Edited by F. Wüstenfeld, 6 vols., Leipzig, 1866–1873. A second geographical dictionary entitled "The Book of Synonyms" (*Al-mushtarik*) was also edited in Arabic by F. Wüstenfeld.

[21] A. F. Mehren, edit.: Cosmographie de Chems-ed-Din Abou Abdallah Mohammed ed-Dimichqui. Texte arabe, publié d'après l'édition commencée par M. Fraehn, St. Petersburg, 1866. Translated, Copenhagen, 1874.

[22] J. T. Reinaud and Stanislas Guyard, edits.: Geographie d'Aboulféda, traduite de l'arabe en français, 2 vols. in 3, Paris, 1848, 1883.

[23] C. Defrémery and B. R. Sanguinetti, edits.: Voyages d'Ibn Batoutah, *Collection publiée par la Société Asiatique*, 4 vols., Paris, 1874–1879. See also Hans von Mžik's more recent edition of the journeys of Ibn Baṭūṭa through India and China: Die Reise des Arabers Ibn Baṭûṭa durch Indien und China (14. Jahrhundert), *Bibliothek denkwürdiger Reisen*, Vol. 5, Hamburg, 1911.

[24] See the chapter entitled "Merits of the Arabic Geographers" (*Vorzüge der arabischen Geographen*) in O. Peschel's "Geschichte der Erdkunde," 2nd edit., edited by Sophus Ruge, Munich, 1877, pp. 158–160.

[25] From such tables of geographical co-ordinates, Joachim Lelewel in the Atlas accompanying his "Géographie du moyen âge," Brussels, 1849, constructed maps on the equidistant cylindrical projection (*Plattkarten*) of a sort never found in Arabic cartography. In this he was followed by Heinrich Haag: Die Geschichte des Nullmeridians, Leipzig, 1913.

[26] The world map must be reconstructed from the text of the "Kitāb ṣūrat al-arḍ." Four detailed maps, however, accompany the manuscript. These are reproduced, together with some specimens of maps of Iṣṭakhrī and Idrīsī, in the article of Hans von Mžik referred to in footnote 3, above.—Edit. Note.

[27] Das "Buch der Abbildung der Länder," Handschrift der Hofbibliothek in Wien, *Mitt. Geogr. Gesell. in Wien*, Vol. 62, 1919, pp. 145–149.

this he writes: "To dispose of them with the bald judgment that they are cartographic barbarisms would be unjustifiable, even though they are completely lacking in everything we regard as requisite for maps and even though we can hardly imagine practical uses to which such productions might possibly have been put. Perhaps we are altogether mistaken in speaking at all of practical uses in this connection, so predominatingly are all the details subordinated to ornamental execution. This is done through the subdivision of the material upon the space to be covered and through the use of colors. Just as the Orientals use writing as ornamentation and in doing so subordinate the literary content of the text to decorative purposes, so here an attempt was made to reach the same result with the means of expression furnished by cartography. The attempt was somewhat primitive, possibly executed without deliberate intent or in a playful spirit, but, for all that, original."[28]

Arabic nautical science has received as yet but little attention. Vasco da Gama seems to have seen a sea chart in the hands of an Arab pilot and to have admired the cylindrical projection upon which it was drawn.[29] Several extant Arabic pilot manuals refer to the actual existence of sea charts, although up to the present time none of the latter have come to light. The manual for the Indian Ocean, the "Book of the Uses of the Principles of Navigation" (*Kitāb al-fawā'id uṣūl ʿilm al-baḥr*) of Shihāb ed-dīn Aḥmed ibn Mājid (1490) has recently been edited from a manuscript of the Bibliothèque Nationale in Paris.[30] The manuscript, however, does not seem to contain charts. This much, however, appears certain, that the first scientific principles of navigation did not originate in Europe with the Portuguese but, like so many other things, were first formulated in the Orient. Siegmund Günther was of the opinion that Moslem navigators used an instrument called *al-kāmil* (the whole, the complete) for determining positions.[31]

Determination of Longitudes and Latitudes of Countries and Cities

As has already been hinted, the determination of latitude and of longitude among the Moslems was a problem for astronomers. In computing longitude they began, either, as the Greeks had done, in the farthest west and counted thence eastward through the 180 degrees of the οἰκουμένη (known world) or else they reckoned east and west for a distance of 90 degrees on either side of a fictitious central meridian passing through the "Cupola of the World" (*Qubbat al-arḍ*) or the "Cupola of Arīn" (*Qubbat-Arīn*),

[28] *Ibid.*, p. 148.

[29] Peschel, *op. cit.*, p. 146.

[30] Gabriel Ferrand, edit.: Livre des renseignements utiles sur les bases et les principes de la science nautique, *Journ. asiatique*, 1918, 1922.

[31] See Siegmund Günther: Die indirekten Ortsbestimmungsmethoden in der Entwicklung der mathematischen Geographie, *Sitzungsber. Bayerischen Akad. der Wiss., Math.-phys. Klasse*, 1919, pp. 299-351, and the critical review of this monograph by the present writer in *Mitt. zur Geschichte der Medicin und der Naturwissenschaften*, Vol. 19, No. 5, pp. 252 ff.

which lay at the center of the earth's surface on the equator. The word *Arīn* is an erroneous transcription of the Greek *'Οζήνη*, which in turn represented the Indian *Uzain*. Though only a few astronomers reckoned from the meridian of Arīn, its accurate identification has brought forth a small literature.[32]

When the Moslems made use of eclipses of the moon to find the difference in longitude between two stations, their results were often inaccurate to the extent of several degrees. This, however, was the method almost always employed by them. Only once, so far as we know, has there come to light a description of a so-called terrestrial calculation of longitudes—in the writings of Al-Bīrūnī. Having determined accurately the shortest linear distance between two points and the latitudes of each, Al-Bīrūnī calculated the difference in longitude from the data thus acquired. This he did in correcting older figures for the distance in longitude between Alexandria and Ghazna, together with the longitudes of a number of intermediate points. This calculation is discussed in a chapter of his famous astronomical geography, "Qānūn Mas'ūdī," a work comparable to the "Almagest" of Ptolemy, though unfortunately still entirely unavailable for the use of students. The present writer, however, has published a German translation of the interesting chapter in question with a commentary.[33] In this connection Al-Bīrūnī set himself the question, "May longitudes be found better by calculating terrestrial distances than through the observation of eclipses?" His answer is as follows:

"If you have found the distance so accurately that you may substitute for it a straight line with a great approach to the truth, the advantage lies with this [the terrestrial] method. The determination of longitudes from eclipses is difficult because both the exact moment of the beginning as well as of the end of an eclipse may be determined only approximately, since (the beginning and the end of the eclipse) is preceded by the contact of two shadow circles. And the moon darkens herself so that her darkened color resembles the smoke of a light in the hand. The contact is delayed in exactly the same way at the departure of the two circles in the course of its (the contact's) disappearance. Then, the circular outline of the shadow is not clear except after one has taken it to a certain extent from the moon according to agreement (Sodann ist der kreisförmige Umriss des Schattens nicht deutlich, ausser man ihn vom Monde etwas nach Übereinkunft genommen hat). In this interval the moon moves farther according to equinoctial time. That which produces gaps in the longitude through addition or subtraction is often to be attributed to the fact that an interval intervenes in the observation, in case the two observers have not come to a previous agreement to serve themselves with their sight and skill according to a formulated plan, and one of them should not go by a river and

[32] See Carl Schoy: Längenbestimmung und Zentralmeridian bei den älteren Völkern, *Mitt. K. K. Geogr. Gesell. in Wien*, Vol. 58, 1915, pp. 27–62.

[33] Carl Schoy: Aus der astronomischen Geographie von Araber: Originalstudien aus al-Qānūn al-Mas'ūdī des arabischen Astronomen Muḥ. b. Aḥmed Abū'l-Riḥān al-Bīrūnī (973–1048), *Isis*, Vol. 5, 1923, pp. 51–74.

the other to the sea."[34] The difference in longitude (24⅛°) between Baghdad and Ghazna found by Al-Bīrūnī by means of the terrestrial method is remarkably accurate.

The technical procedure of the Arabic astronomers in determining longitude by observing eclipses of the moon is clearly explained by the Fatimid astronomer, Ibn Yūnus (died 1009 in Cairo), a man preëminent both in practical and theoretical work and author of the famous Hakimite Tables. The author says:[35] "In the determination of the difference in longitude between two places from an eclipse of the moon it is necessary that for the measurement one be equipped with two very accurate instruments which have been tested by two men of learning and experience: for experience in mensuration is of the greatest importance. In case the two men should have little experience, calculate the number of days which still precede the eclipse: then let the two measure some fixed stars (their altitudes) until the eclipse takes place, and in this way they will have acquired some practice. It is also necessary that the two know accurately the place where the earth's shadow enters upon the edge of the moon's disk in order that the gaze may be directed unflinchingly at the place of contact, and thus the measurement of ells serves the understanding of the eclipse. I have already explained when discussing the calculation of eclipses how one recognizes the place of the first contact. And in regard to that which lies between the two moments of this contact and the instant when the eclipse becomes evident certain of the earlier [astronomers] (predecessors) have said that in the interval between these two moments 1°49′ of the equator turns and this makes 7 minutes 16 seconds of equivalent time. And the matter stands with me almost as mentioned. And now when each of the two has surely (indubitably) noted the eclipse with his eyes, then let him take the altitudes of several fixed stars. Then let each of them reckon from the momentary place of the star and its latitude its [the star's] distance from the celestial equator and likewise the half of its arc which it traverses over the earth, then the variation (3rd inequality) of the moon,[36] furthermore the right ascension of the degree with which it goes through the nona-

[34] This passage and the following passage from Ibn Yūnus have been rendered literally from Dr. Schoy's German translation at the expense of style and clarity in order that there may be the least possible departure from the meaning of the Arabic original. Dr. Schoy describes (*op. cit.*, p. 64, note 2) the passage from Al-Bīrūnī as "etwas knappen und nicht ganz deutlich" (somewhat brief and not altogether clear). The translation as prepared for the *Geographical Review* differs slightly from the form in which it appears in *Isis* (*loc. cit.*).—EDIT. NOTE.

[35] Arab MS., Leiden, No. 143, p. 80. On the English translation of this passage see the preceding note. Phrases and words inserted by Dr. Schoy in elucidation of the text are given in parentheses. The passage was submitted to Dr. W. Carl Rufus of the Detroit Observatory, University of Michigan, Ann Arbor, Mich., who was kind enough to supply the diagram Figure 1 on the following page and the explanation of the passage beneath the diagram. Phrases and words inserted by Dr. Rufus and by the editor of the *Geographical Review* are placed in square brackets.—EDIT. NOTE.

[36] In the manuscript as originally submitted by Dr. Schoy, instead of "the variation (3rd inequality) of the moon," was the phrase: "the difference of culmination (of the passage) of the star (?)." Subsequently, in a letter to the editor of the *Review*, Dr. Schoy suggested that the passage be changed so as to stand as given in the text. Dr. Rufus, however (see preceding footnote), believes that the passage may be interpreted more readily if Dr. Schoy's original reading be retained.—EDIT. NOTE.

gesimus (highest point of the ecliptic, middle of the heavens[37]), likewise the right ascension of the degree which rises with it, and also that part of its arc which has swung above the horizon calculated from the rising to the time of the observation (the *Dā'ir*). Now add to this arc the right ascension

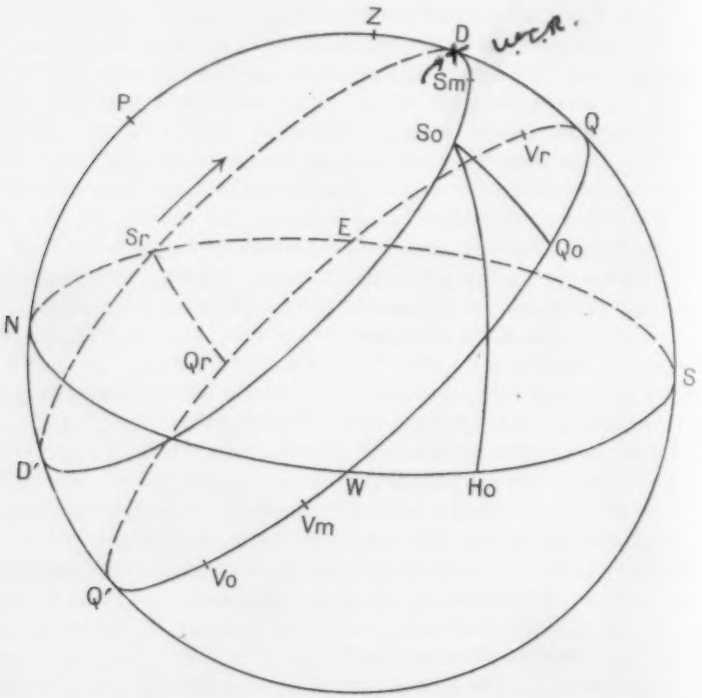

FIG. 1—The circle represents the celestial meridian. NESW is the horizon. QQ′, the equator. DD′, the star's declination circle. Sr, Sm, So, the star at rising, on the meridian, and at the time of observation. Vr, Vm, Vo, the vernal equinox at the same instants.

HoSo, the altitude of the star.

The latitude of the star is not given, as the ecliptic is omitted from the diagram.

QoSo, the star's "distance from the celestial equator," i. e. its declination.

SrD, half of the arc which the star "traverses over the earth," i. e. half its diurnal arc.

QrE, "the difference of culmination (of the passage) of the star" (see footnote 36), which is the difference between the right ascension of the star and the right ascension of the point of the equator which rises with it.

VmQ, "the right ascension of the degree with which it goes through the nonagesimus," (the meridian, see footnote 37). This is the star's right ascension, which is given also by VrQr and by VoQo.

VrE, "the right ascension of the degree which rises with it."

SrDSo, "that part of its arc which has swung above the horizon calculated from the rising to the time of observation." An equivalent arc on the equator is VrQVo.

VoQE, the sum of the two preceding arcs, which is the right ascension of the rising point on the equator at the time of the observation. Hence the correction suggested in footnote 38.

VoQ, the right ascension of the nonagesimus (the meridian), which is local sidereal time expressed in degrees. The difference between the local sidereal times at two points gives the longitude.

[37] Dr. Rufus would substitute "meridian" for "highest point of the ecliptic."—EDIT. NOTE.

of the degree which rises with it; what results is the right ascension of the rising (star)[38] at exactly this moment. We subtract 90° from it, and in case it [the right ascension] is less than 90° we augment it by 270°; that which then results is the right ascension of the degree of the nonagesimus [local sidereal time]. We take the difference between the former and the latter right ascensions (of the nonagesimus, yielded by each single calculation of the two observers in the two places whose difference in longitude was sought): it is equal to the difference in longitude between the two places."

One result of outstanding importance that emerged from Arabic determinations of longitudes was the correction by shortening some 17° of Ptolemy's exaggerated figure for the length of the Mediterranean Sea.[39]

Various Arabic geographers carried out unusually thorough researches leading to the determination of geographical latitudes and thereby contrived methods as original as the results occasionally were accurate. This chapter in the history of Arabic astronomy contradicts the oft-made assertion that Moslem astronomers in no way surpassed the "Almagest" of Ptolemy.

The astronomers of the early Arabic period such as Al-Khwārizmī, Al-Ferghānī, Ḥabash al-Ḥāsib, and Al-Battānī made use primarily of Greek and Indian methods of finding latitude. Greek, for instance, is the reckoning of geographical latitude, ϕ, from the difference between the duration of the longest day and of the equinoctial day at a given station; Indian, the measurement of the meridian altitude of the sun, H, on an equinoctial day so that $H=90°-\phi$, or, in case one prefers to take the sun's declination, δ, $H=90°-\phi+\delta$, whence the required ϕ is directly found. In treatises as early as those of Al-Khwārizmī and Al-Battānī one comes across directions for ascertaining the altitude of the pole (latitude) as the mean between the upper and lower altitudes of culmination of a circumpolar star ($\phi=\frac{h1+h2}{2}$). There has, however, nowhere come to light an example of the actual application of this method expressed in figures, and hence the student is obliged to conclude that the Moslems never put it to practical use. Between the instants of culmination of such stars there intervenes an interval of twelve hours, but in the subtropical regions of Islam night does not last much more than twelve hours. Indeed, it is not impossible that these passages in the texts of Al-Khwārizmī and Al-Battānī are either unauthentic or else were bodily interpolated by a later editor or copyist. How this method was altered so that it might be given practical application has been ascertained by the present writer from a brief account given by Al-Bīrūnī in his "Qānūn al-Masʿūdī." After first treating the manner of finding latitude by the culmination altitudes of a circumpolar star, the astronomer suggests that this method may be applied to the sun, observing that the

[38] Instead of "star" Dr. Rufus believes that "degree" or "point on the equator" should be substituted here.—EDIT. NOTE.

[39] Further details regarding this will be found in L. P. E. A. Sédillot: Mémoire sur les systèmes géographiques des Grecs et des Arabes, Paris, 1842.

mean of the sun's greatest meridian altitude at the beginning of Cancer and of its least at the beginning of Capricorn are equivalent to its equinoctial altitude at the point of observation. In this manner Al-Bīrūnī found the latitude of his dwelling place, Ghazna, to be 33° 35′, certainly an accurate figure. Furthermore, he pointed out that this calculation might be made by referring the sun's altitude to two constellations both the same astronomical distance from the two solsticial constellations, Cancer and Capricorn, and he cited Leo and Sagittarius as examples of constellations particularly well adapted for this purpose. Besides these methods, Al-Bīrūnī knew of a number of other ways of determining latitude, but space will not permit their discussion in the present paper.

Equally individual methods were employed by Ibn Yūnus for ascertaining accurately the latitude of his point of observation, Fosṭāṭ (old Cairo). We mention only the ingenious procedure of finding latitude at the time of the summer solstice from the height of the sun in the east-west circle (1 vertical),[40] according to which Ibn Yūnus placed Fosṭāṭ in latitude 30° N. This figure served to correct figures given by other scholars, among them Abū'l Faraj, known as Ibn aṭ-Ṭaḥḥān (the miller's son), who had asserted that his observations with a sundial set up in Al-Qarāfa had given a latitude of 29° N.

Another very well known Arabic man of science, Ibn al-Haitham (965–1038), the Alhazen of the Occident, devoted a separate work to the exact calculation of latitudes. He recommended taking a bright fixed star for the precise determination of the altitude of the pole, a star which in its upper culmination reaches the zenith or at least comes very close to the zenith. Then, very near the zenith two so-called corresponding altitudes to the east and west of the star shall be taken with the astrolabe. In this way Ibn al-Haitham would eliminate the influence of refraction, known markedly to affect the measured altitudes of stars at greater distances from the zenith. The time which elapsed between the moment the fixed star left its eastern altitude and the moment when, having passed through the zenith or through its maximum altitude, it reached its western altitude, was to be measured as accurately as possible with a water clock. When the two observed heights, the interval between the observations, and, in case the star did not culminate in the zenith, the altitude of its culmination had all been measured, one could calculate the latitude of the place of observation.[41] Ibn al-Haitham gives no illustration of the use of this method in which figures are quoted.

It is possible, however, to cite certain numerical results testifying to the excellence of Arabic determinations of latitude. The sons of Mūsā ben Shākir found, for the latitude of the Bāb aṭ-Ṭāq (Gate of the Arch) at Baghdad, 33° 20′ N.—a figure accurate within a minute. Al-Māhānī

[40] These experiments of Ibn Yūnus and others are discussed by Carl Schoy in *Annal. der Hydrogr. und Mari. Meteorol.*, Vol. 49, 1921, pp. 124–133; Vol. 50, 1922, pp. 3–20.

[41] German translation of this text with commentary is given by Carl Schoy in *De Zee*, No. 10, 1920, pp. 586–601.

found the latitude of Surramanra'ā to be 34° 12′ N., the true figure, according to M. von Oppenheim,[42] being 34° 11′ 50″ N. Similarly the Tatar astronomer Ulugh Beg (died 1449) determined the latitude of the observatory of Samarkand to be 39° 37′ N., corrected by Struve to 39° 38′ 50″ N.

Naturally more inexact figures are also to be found in Arabic astronomical treatises. When latitude was reckoned from the shadow of the gnomon, errors of as much as 15′ crept in, because these shadows were cast from the upper edge of the sun and not from its central point. Ibn Yūnus first called attention to this source of error.[43]

The Size and Shape of the Earth

Divers Moslem authors described the measurement of the earth carried out on the order of the Caliph Al-Ma'mūn in the desert of Sinjar. This gave a terrestrial degree of 56⅔ Arabic miles,[44] a figure accepted by the majority of the Arabic men of science. Besides this we know also of a measurement of a degree which Al-Bīrūnī carried out for himself. This is thoroughly described in the "Qānūn al-Mas'ūdī" (Part V, Ch. 7), where it is stated that Al-Bīrūnī had a highly reliable assistant measure a part of a terrestrial degree in the northern part of Dehistān in the territory of Jorjān and that he later carried this problem to completion in India by measuring the so-called horizontal depression from a mountain 652.05 ells in height. The result was 56 miles, 0′ 50″ 6‴. It is known that these miles each contained 4000 black ells, a measure concerning the exact length of which we are not altogether clear, though it cannot have been far from ½ meter. Al-Bīrūnī adds that this black ell was used in measuring houses and courts in Baghdad, and one may be permitted to suppose that it is still determinable there.[45]

In concluding, to touch for a moment upon the problem of the shape of the earth, we find that the majority of Arabic scholars held that the earth is a sphere floating in space, although there were varying opinions upon this subject in different schools. There is a summary collection of these opinions in the "Work of Costly Treasures" of Ibn Rusteh (about 900), translated into German by Wiedemann.[46]

[42] Max von Oppenheim: Vom Mittelmeer zum Persischen Golf, Vol. 2, Berlin, 1900, p. 221.

[43] See *Annal. der Hydrogr. und Marit. Meteorol.*, Vol. 49, 1921, p. 131.

[44] Mean value of several somewhat divergent figures.

[45] The following special monographs deal with Arabic measurements of a degree: Eilhard Wiedemann: Über die Dimensionen der Erde nach muslimischen Gelehrten, *Archiv für die Geschichte der Naturwissenschaften und der Technik*, 1912, pp. 250–255; Carl Schoy: Erdmessungen bei den Arabern, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1917, pp. 431–445.

[46] Eilhard Wiedemann: Anschauung der Muslime über die Gestalt der Erde, *Archiv für die Geschichte der Naturwissenschaften und der Technik*, 1909, pp. 310–319.

TERRITORIAL REORGANIZATION IN EUROPEAN RUSSIA

NOTES ON THE POLITICAL MAP

Since the World War the chaotic political and economic situation in Eastern Europe has produced frequent changes of boundaries both provincial and national. These changes have not been altogether ephemeral or arbitrary. Many have been determined by relatively permanent geographical factors, and many may be expected to last. Something of the geographical background for understanding the changes may be gained from a recent concise and clearly written regional geography of Eastern Europe by Walther Tuckermann.[1] Within Russia a thoroughgoing territorial reorganization was given recognition by the Soviet government in the autumn of 1921. The boundaries of various so-called autonomous provinces and independent and autonomous republics which had emerged during the Revolution were then determined by decree. The ostensible purpose was decentralization, the concentration of local government in the hands of the divers peoples of Russia. The "republics" and "autonomous provinces" represent ethnic groups which have been established for centuries on Russian soil. The new political map of Russia, consequently, is more or less an ethnographical map as well. This becomes evident when we compare on Figure 1 the boundaries of the autonomous and independent republics and autonomous provinces[2] with the areas occupied by the principal races of European Russia.

For the sake of simplicity we may divide the principal ethnic stocks of European Russia into six groups: Russian, Finnish, Turko-Tatar, mixed stocks of the Caucasus, Kalmuck, German. Besides these there is a scattering population of Jews, Rumanians, Greeks, and others, not represented by territorial autonomy.

1. The dominant Russian stock is divided into three main branches, Great Russian, White Russian, and Little Russian. The Russian Socialist Soviet Republic proper (1),[3] with Moscow as its capital, comprises Great Russia, the old nucleus of the Empire, together with the regions settled by Great Russians. Only four of the administrative provinces into which this

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[1] Walther Tuckermann: Osteuropa. 2 vols., 116 and 124 pp.; maps, ills., bibliogrs., indexes. (Jedermanns Bücherei.) Ferdinand Hirt, Breslau, 1922.

[2] These boundaries are based essentially upon an official map published at Moscow in 1921, for a discussion of which see P. Camena d'Almeida: Une nouvelle carte politique de la Russie d'Europe, *Ann. de Géogr.*, Vol. 32, 1923, pp. 75–79. Plates 138 and 139 of the eighth edition of Andrees Handatlas, 1922, indicate the new political divisions of Russia, including the new provinces of Soviet Russia proper. See also "Artarias Karte der Russischen sozialistischen föderativen Sowjet-Republik," 1:6,000,000, Vienna, 1922 (?) and B. Adler: Übersichtskarte des Bundes der Sozialistischen Sowjet Republiken, S. S. S. R. (Europäisches Russland) 1:6,500,000, Verlag "Kniga," Berlin, 1923.

[3] Numbers in parenthesis refer to the numbers on Figure 1.

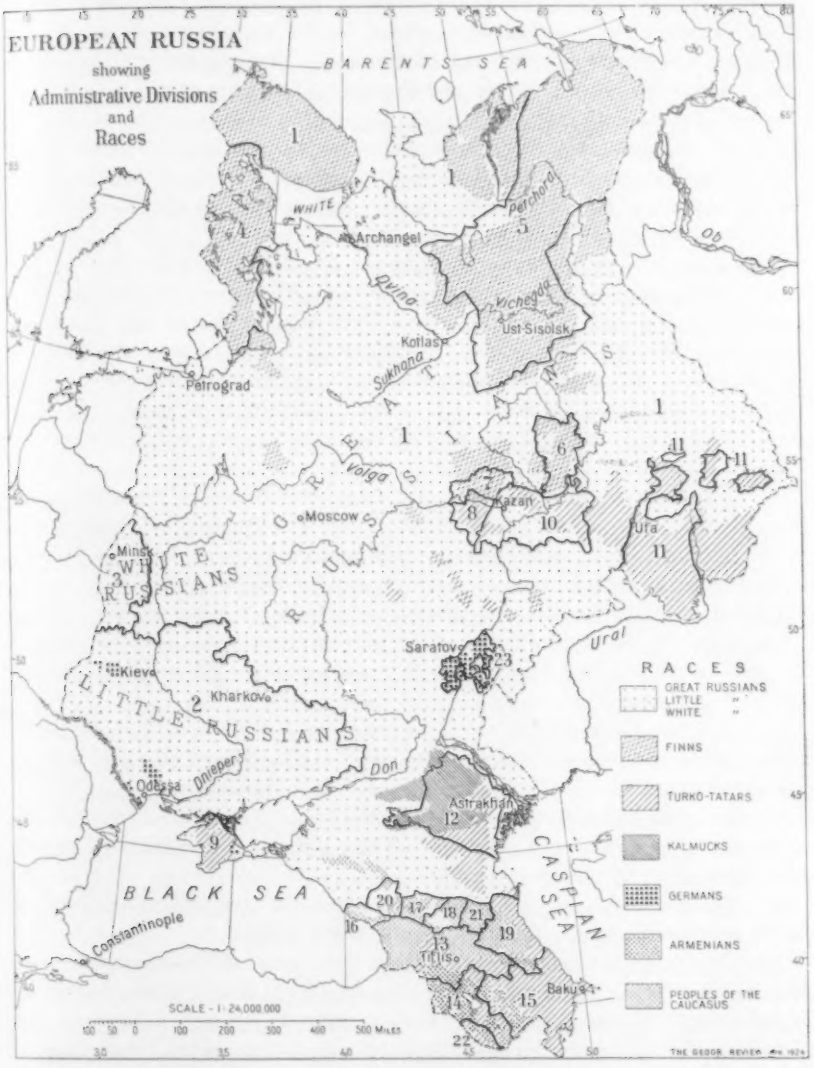

FIG. 1—Map showing the administrative divisions of European Russia, and in relation, the principal ethnic groups. The numbers refer to the following administrative divisions: 1, Great Russia: Russian Socialist Soviet Republic (43 governments); 2, Republic of Ukraine (12 governments); 3, Republic of White Russia; 4, Workers' Community of the Carelians; 5, Autonomous Province of the Zyryans; 6, Autonomous Province of the Votyaks; 7, Autonomous Province of the Cheremisses; 8, Autonomous Province of the Chuvashes; 9, Tatar Republic of Crimea; 10, Tatar Republic of the Middle Volga; 11, Bashkir Republic; 12, Kaimuck Republic; 13, Republic of Georgia; 14, Republic of Armenia; 15, Republic of Azerbaijan; 16, Republic of Abkhazia; 17, Republic of the Kabards; 18, Republic of the Mountaineers; 19, Republic of Daghestan; 20, Autonomous Province of the Karachaevo-Cherkesses; 21, Autonomous Provincee of the Chechenzes 22, Autonomous Province of Nakhichevan; 23, Workers' Community of the Germans.

republic is subdivided retain the same territorial areas as those of the "governments" of the Tsarist régime. In the majority of cases the old divisions have been split up and rearranged. The original partitioning of the Empire into governments and provinces had been made with a view toward approximating equality in the population of each. This resulted in wide differences of area, from the immense, remote, and unsettled Archangel and Vologda governments to the smaller, more thickly populated governments of central Russia. The Soviet policy has been to increase the total number of subdivisions and to split up the larger districts.[4]

Clustering about the borderlands of the Russian Soviet Republic proper and forming enclaves within its territory are the various united republics and provinces. On the southeast two republics represent the two lesser branches of the Russian stock. The largest of these, that of the Ukraine (2), occupies the upland steppes between the Dniester and the Dnieper and the broad plain east of the latter river. North of the Ukraine the small republic of White Russia (3) lies along the Polish border south and east of Minsk.

2. Finnish folk, widely dispersed through the forests of the north, were granted the status of autonomy in five areas: The Workers' Community of the Carelians (4) between Lakes Ladoga and Onega and the shores of the White Sea; the extensive autonomous province of the Zyryans (5) in the far northeast; the smaller autonomous provinces of the Votyaks (6) and Cheremisses (7) in the borderlands of the forest northeast and northwest of Kazan; and the mixed Turko-Finnish province of the Chuvashes (8) west of the Volga near Kazan.

3. Moslem Turko-Tatar stocks, coming originally from Central Asia, have kept to the steppe country of the south. These once nomadic peoples are represented in the Tatar Republic of the Crimea (9), occupying the interior of the Crimean peninsula, in the Tatar Republic of the Middle Volga (10), lying about Kazan and to the eastward, and in the Bashkir Republic (11) of the southern Urals.

4. The Buddhist Mongol Kalmucks comprise a republic (12) situated in the semidesert plains southwest of the lower Volga.

5. The complex of small states of the Caucasus, of Transcaucasia, and of the plains to the north reflect the ethnographical mingling of this region, racially one of the most confused in the world. Three states, however, are of primary importance: the Republics of Georgia (13) and of Armenia (14), composed mainly of Christians, and, to the east, occupying the lower Kur valley, the Moslem Tatar Republic of Azerbaijan (15). To the north lie the four small predominantly Moslem republics of Abkhazia (16), of the Kabards (17), of the Mountaineers (18), and of Daghestan (19) and the autonomous province of the Karachaevo-Cherkesses (20). A small portion of the last-named (not shown on the map) was detached early in 1922 to form a new province of the Cherkesses. The eastern portion of the Moun-

[4] For an analysis of these changes, see *Weltwirtschaft und Statistik*, Vol. 2, 1922, pp. 482–483.

taineers' Republic has also recently been constituted as the autonomous province of the Chechenzes (21). South of Armenia, in the upper valley of the Araxes, is the Moslem autonomous province of Nakhichevan (22).[5]

6. Finally mention must be made of the isolated German settlements planted in the eighteenth century along the Volga in the neighborhood of Saratov. Out of these there has been constituted a Workers' Community of the Germans (23), whose capital, Marxstadt, is the older Ekaterinstadt, named from Catherine the Great. M. Camena d'Almeida remarks[6] that, though these Germans have preserved their language and religion, the influence of physical environment has been so potent that one can scarcely distinguish externally a German of the Volga from a Great Russian.

Recent reports show that, though at first nominally "independent" or "autonomous," the various republics and provinces in reality are entirely subject to Moscow. However, constituted as they were during a time of political anarchy, they may be taken to represent areas into which Russia would tend naturally to split, were the central authority removed or materially weakened. The aim of the central authority during the last two years has been towards further political centralization. By 1923 the autonomy of the Ukraine, and, we may presume of the other states, had been largely done away with. As a measure of suppressing the federal character of Russia the name of the body politic as a whole has been changed from "Russian Federated Socialist Soviet Republic" to "Union of the Russian Soviet Socialist Republics."

A further reorganization of European Russia into twelve "economic regions" was proposed in 1922.[7] Each region was to represent a territorial economic unit, "susceptible of fulfilling one or another function in the general economic dynamics of the country." To the authorities of each was to be left broad scope in the administration of local affairs, and in this respect the proposed regions stood for economic decentralization. On the other hand, as "Spectator" pointed out in *L'Est Européen*, the boundaries of the regions were to be drawn and their capitals located in a manner expressly designed to discourage the nationalistic aspirations of the various racial stocks in favor of the central government. The plan contemplated an interesting experiment in administration. We need but compare these economic regions with the geographical regions marked out by Tuckermann in the volumes referred to above, to see that the proposed organization represented a genuine attempt to adapt an important element of the administrative machinery of a great nation to permanent geographical facts.

Students of the history of political theory as well as of historical geography will find it profitable to compare the highly arbitrary and idealistic

[5] For an historical account of the Moslem republics and provinces see Joseph Castagné: Les organisations soviétiques de la Russie musulmane, *Rev. du Monde Musulmane*, Vol. 51, 1922, pp. 1–254.

[6] Article cited in footnote 2, p. 270.

[7] See *L'Est Européen*, Vol. 3, 1922, pp. 277 ff.; *Riv. di Geogr. Didattica*, Vol. 6, 1922, pp. 135–141.

regional divisions of France adopted and suggested at the time of the French Revolution[8] with the more practical schemes based upon the ethnography, geography, and economic condition of the land adopted and suggested by the leaders of the Russian Revolution.

[8] See the note "A Regional Division of France, 1790." *Geogr. Rev.*, Vol. 14, 1924, p. 144.

NOTES ON THE MAPPING OF AN AREA IN SOUTHERN HONDURAS

By Joseph H. Sinclair

The general geographical relations of the Republic of Honduras are fairly well known especially through the travels and writings of Squier, Wells, and Sapper.[1] It is a mountainous country with only a narrow border of coastal plain on the Atlantic and Pacific oceans and here and there river plains in the interior. The highest mountain summits attain an elevation of 10,000 feet above the sea in the Selague Mountains, Department of Gracias.

About three-fourths of the area of the country has a dry climate, the surface being occupied chiefly by savanas and a characteristic open forest of oak and pine: on the mountain slopes is a limited distribution of tropical and subtropical rain forest.[2] The remaining one-fourth, lying in the north and east, is humid and covered with tropical forests. Climatic conditions are healthful and in the main well suited to the white race over that portion having the semiarid climate. At Tegucigalpa, the capital, at an elevation of 3070 feet above the sea, two years' observations of temperature showed a maximum of 98° and a minimum of 46°; mean temperature of 66° in January and 76° in May, an average of 72° for the year.[3] A single year's observation of rainfall gives 1200 millimeters (47 inches).

Leggett[4] states that the temperature of San Juancito rarely rises higher than 85° F. At San Juancito rainfall measurements during 1920 and 1921[5] show a total rainfall for 1920 of 71.18 inches and for 1921 of 70.82 inches. The number of days on which rain fell in 1920 was 179, in 1921, 193. The greatest rainfall for each year occurred in the month of June, there being 16.19 inches in June, 1920, and 15.50 inches in June, 1921. The greatest single rainfall was 5.57 inches in 1920 and 4 inches in 1921. Mosquitoes are limited to the coastal plain areas, and hence malarial fevers are uncommon in the great interior highlands. In travels of more than two years the writer and his associates never slept under mosquito netting and did not meet with any one suffering from malaria.

[1] E. G. Squier: Notes on Central America, Particularly the States of Honduras and San Salvador, New York, 1855.

William V. Wells: Explorations and Adventures in Honduras, New York, 1857.

Karl Sapper: Beiträge zur physischen Geographie von Honduras, *Zeitschr. der Gesell. für Erdkunde zu Berlin*, 1902, pp. 33–56, 143–164, and 231–241.

[2] See the vegetation map by Sapper, *op. cit.*, Pl. 3.

[3] Julius Hann: Handbuch der Klimatologie, Vol. 2, Stuttgart, 1910, p. 332.

[4] T. H. Leggett: Notes on the Rosario Mine at San Juancito, Honduras, C. A., *Trans. Amer. Inst. of Mining Engineers*, Vol. 17, 1888–1889, pp. 432–449.

[5] Private Report of A. R. Gordon, Vice President and General Manager of the New York and Honduras Rosario Mining Company, January 1, 1922.

General Character of the Area Mapped

It is the purpose of the present paper to give data on the elevations, geographic position, and topographic character of about 900 square miles situated in the southern part of Honduras between the village of San Lorenzo on the Gulf of Fonseca and a point a few miles north of Tegucigalpa.

Fig. 1—Reduction of the map of the San Juancito Mountains made by the author. The scale of the original is 1:12,000. The inset shows by diagonal ruling the area covered by triangulation (see Fig. 2): the black spot north of Tegucigalpa is the area of the contoured map.

In form this is a narrow rectangle about 80 miles long and 15 miles wide, the longer dimension having a north-south direction.

This region is situated in the semiarid portion of Honduras referred to above and ranges in elevation from sea level to 7500 feet above the sea in the San Juancito Mountains. The San Juancito Mountains, northeast of Tegucigalpa, are the chief mountain mass in the area. Not only is the mass important from its size and elevation, but it is famous for its mines of silver and gold which have been worked for centuries. The New York and Hon-

duras Rosario Mining Company[6] has now been mining here for over 40 years with a total bullion production (from 1882 to and including 1921) amounting to $30,354,754. There are several companies mining in this range, but none approach in importance that of the above-named company. The magnitude of the mining operations by this one company may be further realized from the fact that there are over 40 miles of tunnels on this property penetrating the San Juancito Mountains at levels of over 1600 feet vertical range. While in general the mountain summits of southern Honduras are treeless, the San Juancito Mountains form an exception. Their greater height exposes them to the trade winds and leads to greater precipitation, whence the upper portion of the range is clothed with forest. On the immediate summit, the highest elevation of which is 7500 feet, the forest consists of hardwoods. Here fog prevails; and the great trees, covered with an intense parasitical growth, constantly drip moisture. Before the exploration carried on by us the highest portion of this range had probably been rarely visited. At about 6000 feet the hardwoods give place to forests of pine; and at lower altitudes the forests before disappearing become completely open and parklike.

Next in importance to the San Juancito Mountains is the Sierra de Lepaterique, situated to the southwest of Tegucigalpa. We visited only the eastern portion of this mass, a summit called the Cerro de Hule, whose elevation we found to be 5637 feet above the sea. It is entirely bare of trees. The openness of the country is extraordinary. We often saw the volcanic peak of San Miguel in San Salvador, 90 miles distant, and from far in the interior the great peak of Conseguina in the Gulf of Fonseca.

The mountainous masses in the area described by us are of no regular form. They appear to be remnants of flows of lavas and ash deposits from fairly recent volcanic activity which doubtless formerly covered a much wider area. The Cerro de Hule of the Sierra de Lepaterique range is a broad, dome-shaped summit with smooth and gentle slopes; while on the other hand the San Juancito Mountains are a narrow, jagged ridge with sharp peaks and precipitous slopes which drop very abruptly from elevations of 7500 to 2500 feet above the sea. The great valleys carved back into this range offer scenic views of grandeur. They have cut through the andesites forming the summit and sides of the range and in places have exposed the underlying sedimentary rocks. In the contact zone occur the fissure veins whose mineral content has caused the extensive mining operations already referred to.

In 1909 the New York and Honduras Rosario Mining Company found itself in a position to enlarge the scope of its operations by the construction of new and larger mills for the treatment of the ore and by the construction of new hydro-electric plants and a new town for the accommodation of its

[6] W. A. Thatcher: Mining in Honduras, *Trans. Amer. Inst. of Mining Engineers*, Vol. 20, 1891, pp. 394–409. See also A. T. Haeberle: A Visit to the Department of Olancho, Honduras, *Bull. Pan. Amer. Union*, Vol. 34, 1912, pp. 588–606.

American and English employees. In connection with an intensive campaign for finding new ore deposits, it was decided to have the region accurately mapped topographically and geologically, and in the carrying out of the work the data published in this paper were secured. It is through the courtesy of the company that the results are now published.

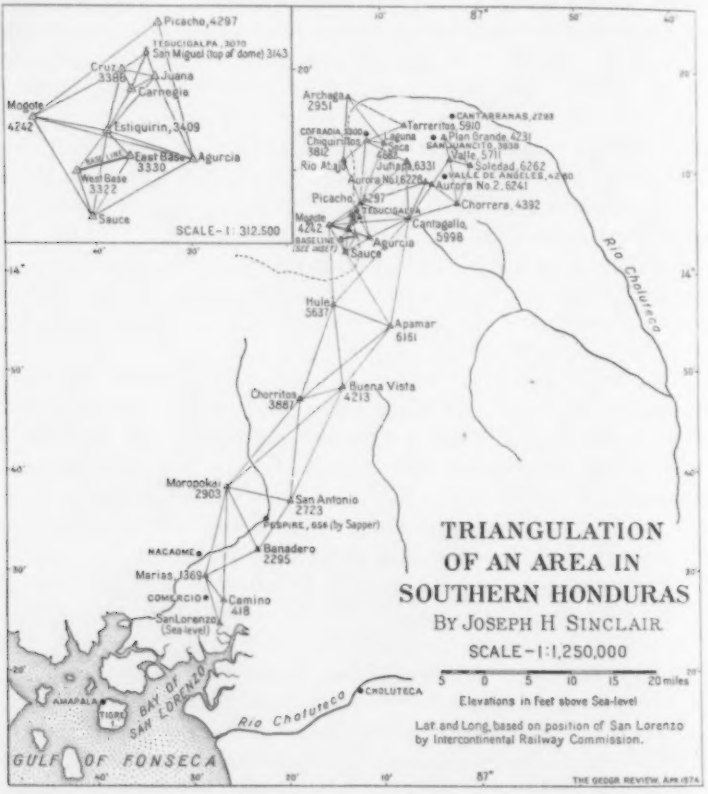

FIG. 2—Map showing the triangulation system carried out by the author in southern Honduras. The inset shows the area about Tegucigalpa on an enlarged scale.

DESCRIPTION OF THE MAPPING

Survey operations began with the measurement of a base line on a plain called the "Llano de Potrero" situated about four miles south of Tegucigalpa. The length of this line was 1½ miles. From this a system of triangulation was extended over an area of about 900 square miles covering the San Juancito Mountains and extending south to the Pacific Ocean. Thirty-six stations were established, nearly all on prominent mountain peaks.

No observations for latitude and longitude were made by us because we were able to include as a station of our triangulation a point whose geo-

graphic co-ordinates had been determined with greater precision than was possible for us with the instruments and time at our disposal. This was the village of San Lorenzo on the Gulf of Fonseca, a station of the survey of Corps No. 1 of the Intercontinental Railway Commission[7] whose position we took from map XVI, sheet La Brea to Los Prados, as latitude 13° 24′ 36″ N. and longitude 87° 27′ 18″ west of Greenwich. Recalculating back from this point through the entire system of triangulation we have obtained the latitudes and longitudes of the entire region covered by it. Thus for the first time we know accurately the position of many towns—Tegucigalpa, San Juancito, Valle de Angeles, Cantarranas, Cofradia, and others.

The astronomic work carried on by us was limited to observations for azimuth on the star α Ursae Min. on July 31 and August 1, 1910. Later these observations were checked by incorporating an azimuth of the Carnegie Institution of Washington at Tegucigalpa[8] as a side of our triangulation, whereby an agreement within fourteen seconds was obtained.

The extension of the system of triangulation to the seacoast at San Lorenzo permitted us to carry elevations all over the triangulation by means of vertical angles between stations. Thus a large number of elevations has been secured of much greater accuracy than any hitherto obtained in Honduras. Fifty-one vertical angles were observed over the triangulation system, the average angle being 6° 02′ and the average length of sight 6.443 miles. A comparison of some of our elevations with several of those of Sapper[9] is as follows:

Place	Barometrical Elevation by Sapper in Feet	Vertical Angle Elevations by Sinclair in Feet
Tegucigalpa*	3214	3070†
Cofradia	3608	3300
Valle de Angeles	4493	4280
San Juancito*	4034	3838
Cantarranas	2394	2293

* Leggett, *op. cit.*, Tegucigalpa 2465 to 2500 feet elevation and San Juancito 3050 feet.

† This is on the assumption that the difference between the ground and the highest point of the rear dome of the cathedral of San Miguel at Tegucigalpa is 73 feet.

A contour map on a scale of 2000 feet to the inch, or 1:12,000, with a contour interval of 20 feet was made of 36 square miles of the higher portion of the San Juancito Mountains, and a copy of this is in the files of the American Geographical Society in New York. The data for this map were obtained by traverses with the plane-table and the stadia extending over a period of two years.

[7] Intercontinental Railway Commission: Reports of Surveys and Explorations, 7 vols., Washington, D. C., 1895–1898.

[8] L. A. Bauer: Land Magnetic Observations, 1905–1910 (Researches of the Department of Terrestrial Magnetism), *Carnegie Instn. Publ. No. 175*, Washington, D. C., 1912.

[9] Karl Sapper, *op. cit.*

In the following list of the elevations and geographic positions of 38 stations of the triangulation system, it should be noted that the names of these stations have been chosen by us arbitrarily. Some, perhaps most, of these stations can never be found accurately enough for extension of triangulation from them; but the elevations represent a permanent contribution to physiography, and where the stations occupy a sharp peak it is certain that such points could be used in extension of a secondary triangulation for mapping purposes.

Appendix

The following list of triangulation stations shows altitude, latitude, and longitude. A complete description is on file with the American Geographical Society.

Table I—Triangulation Stations in Honduras

Stations	Latitude	Longitude	Elevation (Feet)
Agurcia	14° 03′ 10.297″	87° 11′ 11.153″	——
Apamar	13° 54′ 08.834″	87° 09′ 21.601″	6161
Archaga	14° 17′ 19.892″	87° 13′ 30.515″	2951?
Aurora No. 1	14° 08′ 36.250″	87° 05′ 25.737″	6228
Aurora No. 2	14° 08′ 31.832″	87° 04′ 59.216″	6241
Bañadero	13° 31′ 45.469″	87° 23′ 29.804″	2295
Buenavista	13° 48′ 10.233″	87° 14′ 11.137″	4213
Camino	13° 26′ 47.389″	87° 26′ 57.878″	418
Cantagallo	14° 05′ 07.118″	87° 07′ 15.462″	5998
Carnegie	14° 05′ 06.760″	87° 12′ 57.188″	——
Cerro de Hule	13° 56′ 26.021″	87° 15′ 18.942″	5637
Chiquirillos	14° 12′ 37.917″	87° 11′ 32.177″	3812
Chorrera	14° 06′ 26.842″	87° 02′ 11.810″	4392 (top of flag)
Chorritos	13° 46′ 53.243″	87° 18′ 50.473″	3887
Cruz	14° 05′ 29.060″	87° 13′ 19.782″	3386
East Base	14° 03′ 12.977″	87° 13′ 07.009″	3330
Estiquirin	14° 03′ 59.604″	87° 13′ 35.606″	——
Juana	14° 05′ 16.139″	87° 12′ 34.841″	——
Jutiapa	14° 10′ 41.540″	87° 07′ 22.024″	6331
Laguna Seca	14° 12′ 31.835″	87° 09′ 34.112″	4682
Las Marias	13° 29′ 26.373″	87° 28′ 51.110″	1369
Mogote	14° 04′ 13.578″	87° 15′ 36.260″	4242
Montanita	14° 20′ 08.712″	87° 07′ 43.489″	——
Moropokai	13° 38′ 27.384″	87° 26′ 32.536″	2903
Picacho	14° 06′ 40.859″	87° 12′ 08.199″	4297
Plan Grande	14° 13′ 02.419″	87° 03′ 44.811″	4231
Rio Abajo	14° 10′ 45.749″	87° 13′ 55.783″	——
San Antonio	13° 36′ 58.033″	87° 20′ 02.905″	2723
San Lorenzo	13° 24′ 36.000″	87° 27′ 18.000″	15.6
San Miguel*	14° 05′ 57.383″	87° 12′ 43.929″	3143 (highest part of dome)

* Leggett, *op. cit.*, makes Tegucigalpa lat. 14° 15′ N., long. 87° 10′ W.

Stations	Latitude	Longitude	Elevation (Feet)
Sauce	14° 01′ 36.438″	87° 13′ 58.723″	——
Soledad	14° 10′ 11.741″	87° 00′ 56.712″	6262
Station B	14° 12′ 56.304″	87° 05′ 33.079″	5725
Station E	14° 12′ 22.466″	87° 05′ 29.124″	5129
Station F	14° 12′ 20.770″	87° 05′ 14.921″	5080
Tegucigalpa See San Miguel			
Terreritos	14° 14′ 17.754″	87° 07′ 43.246″	5910
Valle	14° 10′ 49.564″	87° 03′ 01.637″	5711
West Base	14° 02′ 54.768″	87° 14′ 23.875″	3322

TIDAL CURRENTS IN THE OPEN SEA: SUBSURFACE TIDAL CURRENTS AT NANTUCKET SHOALS LIGHT VESSEL

By Embert A. Le Lacheur
U. S. Coast and Geodetic Survey

The question is often asked, Is there a tide in the open sea? If there is such a phenomenon, is the current which accompanies it appreciably felt by the navigator? To answer these questions we must first know the difference between the terms "tide" and "tidal current."

The tide-producing forces of the sun and moon cause the water of the ocean to rise and fall vertically, resulting in the daily high and low tides with which we are familiar. Accompanying this vertical movement of the water a horizontal movement also takes place, resulting in the tidal current, commonly known as "flood" and "ebb."

Out in the open sea the vertical rise and fall of the water brought about by the tides is very slight and need not be taken into account by the mariner. The horizontal movement of the tidal current, however, is of considerable importance to the navigator when "on soundings." Offshore, away from the immediate influences of the coast, the tidal current is quite different from the current found in inland tidal waters. Instead of setting in one direction for a period of six hours and in the opposite direction during the following period of six hours, the tidal current offshore changes its direction continually, so that in a period of about twelve and a half hours it will have set in all directions of the compass. This type of current is called a rotary current in distinction from the reversing type of current found in inland tidal waters, such as the Delaware or Hudson Rivers.

Nantucket Shoals Light Vessel, in latitude 40° 37′ 02″ N. and longitude 69° 37′ 06″ W., is located farther offshore than any other light vessel on either the Atlantic or Pacific coasts of North America and is the first aid to navigation picked up by all ocean liners bound to New York from European ports. This station is approximately forty miles south by east from Nantucket Island, which is the nearest land, and fourteen miles southeast from Asia Rip, Phelps Bank, Nantucket Shoals. The light vessel is anchored in twenty-nine fathoms of water and is free to swing with current and wind to considerable anchor chain.

The Surface Current

The tidal current at Nantucket Shoals Light Vessel is of the rotary type, turning clockwise, as shown in Figure 1. In this diagram the times and velocities of the current have been referred to the times of the predicted tides

for Boston, Mass. The diurnal inequality in the tides is likewise reflected in the tidal current, as shown by the two ellipses in Figure 1. In the diagram, HH stands for higher high water, LL for lower low water, H for high water,

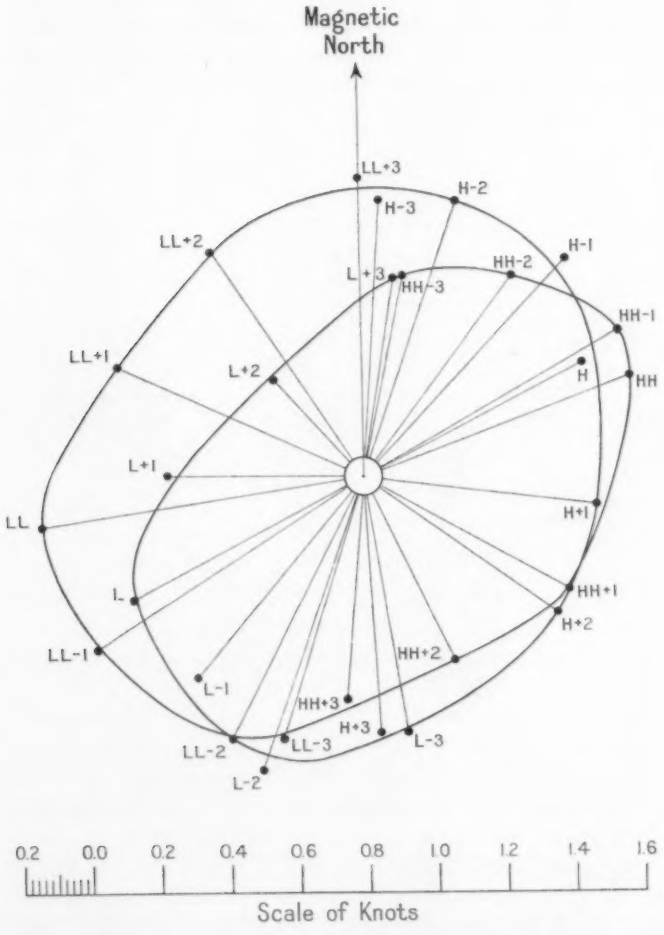

FIG. 1—Surface tidal current curve, Nantucket Shoals Light Vessel. September 1–29, 1919. Times and velocities are referred to predicted tides at Boston, Mass.

and L for low water. Twice in a lunar day of 24 hours and 50 minutes the tidal current swings around in a complete ellipse. Figure 1 shows the mean tidal current at Nantucket Shoals Light Vessel for the lunar month of Sept. 1–29, 1919. It will be noted that the major axes of the ellipses lie in a direction northeast-southwest.

The maximum flood surface current at the light vessel occurs about two hours before low water at Boston and sets S. 35° W. (true) with a velocity of 0.85 knot. The maximum ebb surface current occurs about two hours before high water at Boston and sets N. 35° E. (true) with a velocity of 0.85 knot. The minimum current before flood at the surface occurs about forty-five minutes after high water at Boston and sets southeasterly with a velocity of 0.65 knot, and the minimum current before ebb at the surface sets northwesterly with a velocity of 0.65 knot about fifty-five minutes after low water at Boston.

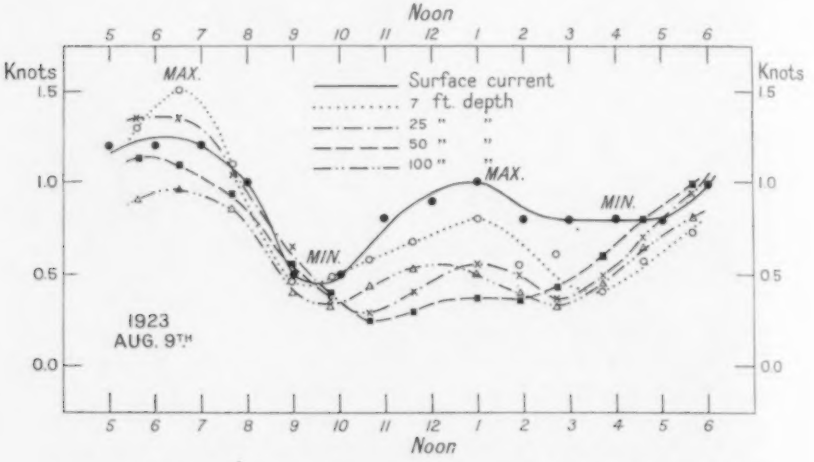

FIG. 2—Graph showing velocities of the current at the surface and at various depths at Nantucket Shoals Light Vessel, August 9, 1923.

A characteristic feature of the rotary current is the absence of slack water, such as occurs in a tidal river when a current which has been flowing ebb turns and flows in an opposite direction on the flood, and vice versa. Although the current generally varies from hour to hour, this variation from greatest current to least current and back again to greatest current does not give rise to a period of slack water. The minimum and maximum velocities of a rotary current are thus related to each other in the same way as slack and strength of current, a minimum velocity of the current following a maximum velocity by an interval of about three hours and being followed in turn by another maximum after a further interval of three hours.

For several years past, pole observations, which give the direction and velocity of the current at a mean depth of 7 feet, or, approximately, the surface current, have been made hourly at Nantucket Shoals Light Vessel. These have resulted in a very good determination of surface current conditions at this station. The directions and velocities of the maximum and

minimum tidal currents have been well determined. The observations indicate the existence of a non-tidal set, due primarily to winds, setting northwesterly with an average velocity of 0.17 knot from April to October and southeasterly with an average velocity of 0.13 knot from November to March.

From a long series of current pole observations—1911 to 1923 inclusive—it has been found that the velocity of the current due both to tide and

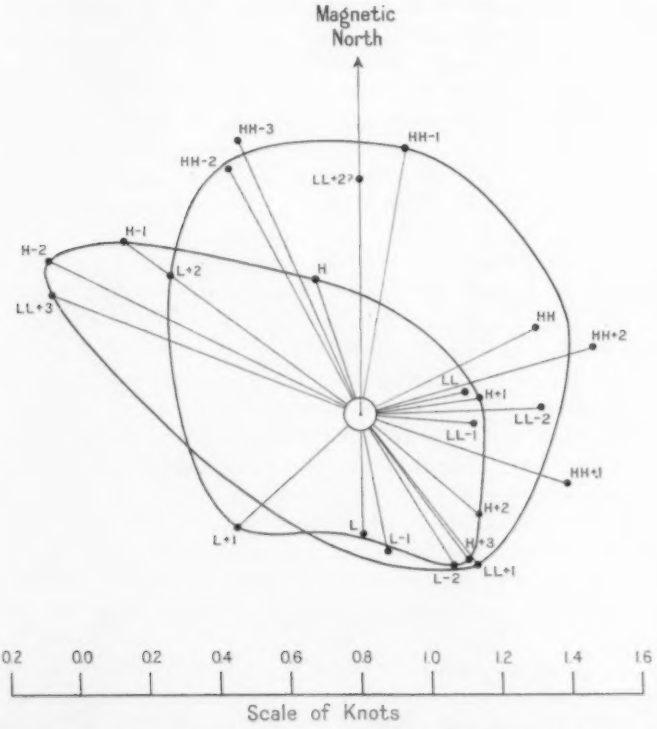

FIG. 3—Tidal current curve at a depth of 100 feet, Nantucket Shoals Light Vessel, August 8–10, 1923. Times and velocities are referred to predicted tides at Boston.

wind at Nantucket Shoals Light Vessel rarely exceeds two knots. The greatest observed velocity at this station occurred at 7 A. M., on December 8, 1913, when the current attained a strength of 2.5 knots an hour. A strong west-northwesterly gale with a velocity of 60 miles an hour obtained at this time.

SUBSURFACE CURRENTS

From August 8 to August 11, 1923, current observations at various subsurface depths, as well as those at the surface, were made at Nantucket

Shoals Light Vessel. The apparatus used consisted of a Price current meter and a bifilar suspension current direction indicator. The velocities and directions of the currents were observed at depths of 7, 25, 50, 100, and 150 feet, respectively.

The velocities of the currents observed on August 9, 1923, at the above-mentioned depths, together with the surface current observations, have been plotted in Figure 2. The time interval from 5 A. M. to 5.30 P. M. represents half a lunar day. It will be noted that the velocities of the current at a given time generally decrease as the depth increases. The maximum and minimum velocities of the current at various depths are indicated by the plottings. The symbol Max. refers to the maximum current, and the symbol Min. to the minimum current. It will be noted that two maximum and two minimum velocities occur at each depth during a twelve-and-a-half-hour period. This would correspond to strength of flood, slack before ebb, strength of ebb, and slack before flood in the case of a reversing tidal current such as obtains in a tidal river like the Delaware or a tidal bay like the Chesapeake.

While this current series (Aug. 8–11, 1923) is rather short in extent, the results obtained indicate clearly that the subsurface tidal currents at this offshore station act quite differently from those at the surface. This is true in direction as well as velocity of the current at a given time. Figure 3 shows a plotting of the current observations at a depth of 100 feet, or, roughly, two-thirds of the distance from the surface to the bottom. These observations have been referred to the times of the predicted high and low waters for Boston, Mass., similarly to those shown in Figure 1. The minus sign means "earlier than," and the plus sign "later than" the tides at Boston. For instance, in Figure 3 the direction of the current at a depth of 100 feet at Nantucket Shoals Light Vessel was N. 82° E. (magnetic) one hour after the time of high water at Boston, shown on the diagram by "H+1". It will be noted that the current is rotary, swinging around in a clockwise direction. However, the major axes of the two ellipses lie northwesterly-southeasterly, or 90 degrees in a counterclockwise direction from those representing the surface current. For depths from the surface to 100 feet, the axes of the ellipses gradually swing around in a counterclockwise direction. This shows, therefore, that the maximum current occurs much later at subsurface depths than it does at the surface.

The results of these offshore observations bring to light probably for the first time the facts that, although the subsurface currents are rotary in type, they lag behind the surface current in direction and have a velocity considerably less than the surface current. In this short series of observations this lag is very noticeable at depths of 25 feet, 50 feet, and 100 feet.

NOTES ON THE MAPPING PROGRAM OF THE THIRD ASIATIC EXPEDITION IN MONGOLIA

By Frederick K. Morris

An account of the work of the Third Asiatic Expedition was given by the leader, Roy Chapman Andrews, at the December Meeting of the American Geographical Society. The following brief notes regarding the survey work in a vast unknown terrain are supplied by Professor Morris, geologist and topographer to the Expedition.

The Gobi is a vast inland basin, made by a warping or bending of the earth's crust, so that a cradle-like depression lies between the two upraised edges that border Mongolia on the north and south. From the northern

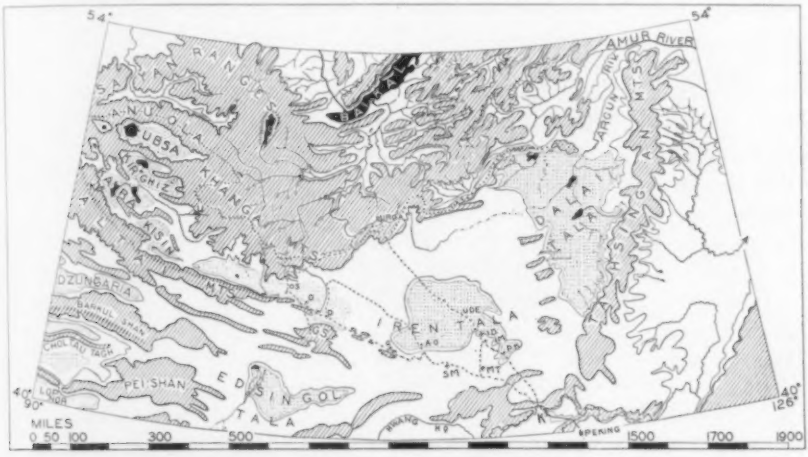

Fig. 1—Physical geography of Mongolia. The mountain areas are shaded with slanting lines. Three kinds of mountain uplift may be distinguished—the short fault blocks east of Lake Baikal; the broad gentle upwarp of the Khangai Mountains; and the long narrow fault blocks of the Altai and the ranges to the southward. The great warped basins are white, but the deeper depressions, *talas*, of these basins are shaded with dots. Most of the sediments bearing remains of extinct vertebrates are found in the talas. The route of the Expedition is shown in broken lines, the major hydrographic divide in heavy round dots.

Index letters are given in succession from Peking north and west: K, Kalgan; PK, Pang Kiang; IM, Irdin Manha, where titanotheres were found; ID, Iren Dabasu, a dinosaur locality; MT, Murukh Tchu; SM, Shara Murun, a titanotheres station; AO, Ardyn Obo, Cadurcotherium beds; G, Golobai-in-Ola; D, Djadochta, dinosaurs and their eggs; O, Oshih or Ashile, dinosaur locality; OS, Ondai Sair, a dinosaur locality, just south of which lie the Baluchitherium beds and the Miocene and Pliocene formations.

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edge we pass through a wide belt of mountain country to the great lowland of Siberia; from the southern, the land surface drops abruptly into China. A great chain of such uplifted basins lies across the continent of Asia, including the Gobi, Dzungaria, the Lop or Tarim, the Tsaidam and Tibet, the Iran and Sistan, the Balkhash, Aral and Caspian basins.

FIG. 2—Sketch showing the edge of a great hollow or lowland eroded in the horizontal sediments of the Gobi. The sketch also shows an *obo*, or devotional stone pile. This one is called Ardyn Obo (see Fig. 1), which freely translated means "Prayer Pile of Jewels," an allusion to the brilliantly polished pebbles here found in the upper conglomerates. This obo can be seen for twenty miles.

ASPECTS OF THE COUNTRY

The rock surface of the Gobi is interrupted by broad shallow depressions in which are found deposits of gravel, sand, and clay that here and there carry the bones of extinct animals. Breaking the level surface of these sediments are smaller depressions or hollows, where the sand and clay have been eroded away and the cut edges of the sediments are exposed. Rising above the level surface of the sediments are knobs of the hard rock floor, some of them small, others large enough to form considerable areas of mountain country.

In the easterly section between Kalgan and Urga there is a seemingly endless succession of these sedimentary basins, parted by low broad mountain masses. In the west, the Altai ranges rise as a long chain of fault blocks with their steep front on the north. In this western region, too, we find sediment basins both north and south of the Altai. To the south, where the two geologists of the Expedition made a brief reconnaissance in 1922, there seem to be vast areas of monotonous basin land. On the north the sediment basins are more rugged, more deeply dissected, and interrupted at many places by low ranges of ancient rocks that stand above the broad level lowlands of sediment like islands in a sea.

The broad extent of the Khangai Mountains, to the north and northeast of the Altai, is maturely dissected and gently sloping, rising gradually to about 10,000 feet at the Arctic divide and then descending along a still gentler slope northward into the lowlands of Siberia. The only traces of glaciation seen by members of the Expedition were the young cirques of the Khangai.

The western limits of the Gobi are in the mountains that group between the Altai and Sayan systems; while to the southwest are gaps or gateways opening into the lowlands of Dzungaria and the Tarim basins.

The area of Mongolia is given according to recent estimates as about one and a third million square miles, or nearly half the area of the United States. The Expedition could cover only a small fraction of this vast territory in the reconnaissance journey of 1922; and in 1923 the regions that had proved to contain vertebrate fossils were studied intensively, so

FIG. 3—Sketch of the major divide in the Khangai Mountains, looking northwest. All rivers seen in the sketch flow southward into the Gobi. The rivers north of the divide flow through Siberia to the Arctic Ocean. Alpine glaciers have carved cirques in the broad rounded surface of these very mature mountains.

that not much new territory could be added to the survey. The route of the Expedition, shown on the map, is in the aggregate about 3600 miles long. So large a course would have been impossible for an expedition lacking motor transport, because the season in which scientific work can be done is only five months long. We go out in the early spring, taking advantage of a short period of warmth that lasts a week or two. Then the cold strikes us sweeping down from the northwest, and in an hour the season has changed from spring back again to winter until June comes round again. Summer is clear and hot but brief. A cool sharp freshness, like the feel of wind-blown ocean spray, comes in the early mornings about mid-August and warns us that our working season is nearly done. We do not start back until September; but we are very likely to run through blizzards before we drop down from the great pass above Kalgan.

To explore such a country with camels at twenty miles a day would be almost impossible; the paucity of scientific results of many previous expeditions that have traversed Mongolia is surely due in part to their lack of adequate transport. So the Third Asiatic Expedition traveled in motor cars—four light trucks and one touring car—supported by a caravan of camels. The mode of travel has been fully described by Mr. Andrews in the serial narrative published in *Asia*.

THE TOPOGRAPHICAL RECORD

The recording of topographical notes in such a country presented rather peculiar problems. Depending chiefly upon the time available, some four types of record were devised, which are stated in ascending order from the least to the most detailed.

When the Expedition was moving at great speed from one base to another, rapid freehand sketches were made of the passing hills. These for the most part were sketched without stopping the car. They make no pretense to quantitative value, but they give the quality of the country. An effort was made to record in this way every notable change in the kind of topography through which the Expedition passed.

When the two geologists were working together, one of them sketched a route map while moving from place to place, as a better record than the

pictorial sketches. Distances were read in miles from the speedometer; aneroid readings gave elevations along the road; and other elevations were judged by eye. Lateral distances were estimated or were somewhat controlled by a crude triangulation. When bearings were to be taken, the car was stopped and the directions were read by stepping away from the car and sighting with a Brunton compass. About 1500 miles of such route map have been made. With all its imperfections, it still remains a more definite record than has yet been made in these regions.

When the Expedition camped for a while, a more regular type of map

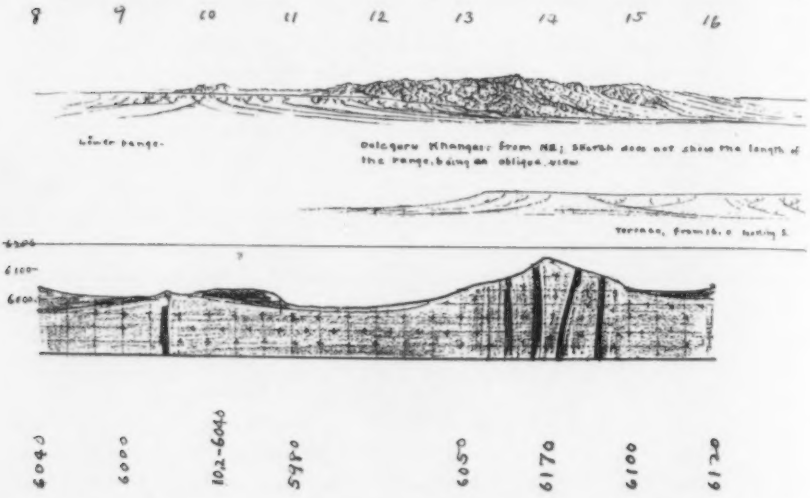


FIG. 4—Page of geologist's notebook (reduced scale), showing a sketch rapidly made from the moving car. The mountain block here represented is called Deleguru Khangai and is entirely unknown to the outside world. It is not to be confused with the Khangai Mountains, which lie more than 100 miles northwest of Deleguru. The figures along the top of the page are miles; those along the base are altitudes in feet, read from an aneroid barometer. A geological cross section is constructed for the entire route.

was made. Rapid compass surveys, controlled by pacing and triangulation, were entered directly in the geologists' notebooks. From time to time these were compiled upon a summary map, so as to cover a larger region. The scale was ¼ inch to the mile, and the contour intervals generally employed were twenty or forty feet.

At all important camps observations were made for latitude and longitude. Latitude was determined by observing the polestar. A single observation is sufficient if one applies the necessary corrections; but to insure accuracy the geologist took a series of readings at intervals of half an hour. Plotted on co-ordinate paper these points were tested by passing a circle through them, which would have revealed any errors. Longitude was determined by the sun; and here also, to guard against errors, a long series of readings was taken and carefully plotted. We shall carry wireless apparatus for the next field season; but we relied upon chronometer watches

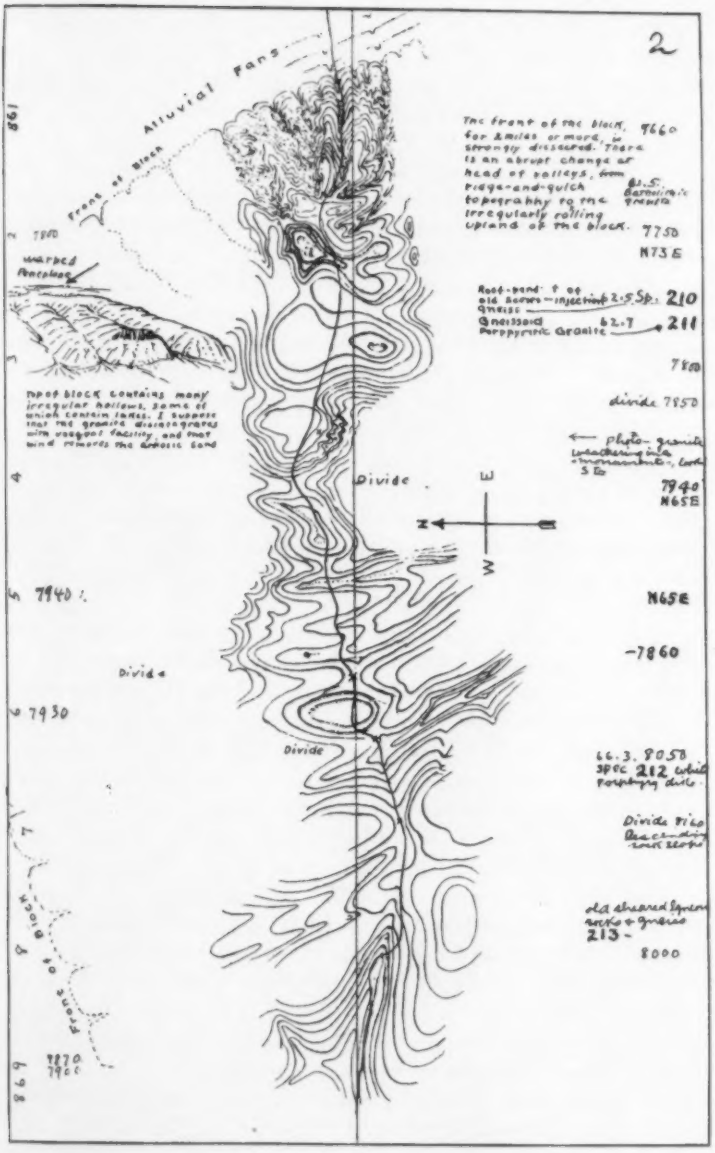

2
Alluvial Fans
Front of Block
The front of the block, for 2 miles or more, is strongly dissected. There is an abrupt change at head of valleys, from ridge-and-gulch topography to the irregularly rolling upland of the block.
7660
7750
N73E
Roof-pend. of old Schist
Gneiss
Porphyritic Granite
Divide
Divide
Divide
Divide
N65E
7860
7940
7930
7870
7960
8000
Top of block contains many irregular hollows, some of which contain lakes. I suppose that the granite disintegrates with exfoliation and that wind removes the arkosic sand

FIG. 5—A page of the geologist's field notebook, showing a section of the route map, sketched in the motor car and drafted in camp at night. This map shows the end of a broad low fault block, in whose peneplaned upland surface are a number of undrained hollows holding small lakes. These hollows are the result of atmospheric weathering and removal of the products of weathering by wind. The rock is granite.

in 1922 and 1923. One of the watches was loaned to the Expedition by the Geological Survey of China, and the Expedition is indebted to the Survey also for the loan of a light mountain theodolite in 1922. In the second season a large transit was used, and the heavier instrument is most heartily recommended. The Expedition has acquired a large Gurley transit, with straight leg tripod, for 1925.

When especially interesting regions were studied, maps were surveyed with a Gurley explorer's alidade and a light plane-table, which carried a sheet 18 by 24 inches. The stadia rods were designed by the geologists upon strips of heavy cloth-backed paper that could be rolled up when not in use. The reading face of the rod is four inches broad, providing excellent visibility. An interesting aid to the survey was found in the stone monuments called *obos*, which the Mongols have built. Each stone is said to represent a prayer to Buddha, and surely each monument evoked a blessing from the topographer. Almost every hill is crowned with an obo, so that in triangulating the map-maker may sight upon the very same spot every time he uses that hill in intersection or resection, or for a set-up.

Maps were drawn to the scales of an inch to the mile or two inches to the mile. Contour intervals varied with the quality of the ground—10 feet, 20 feet, and 100 feet. The largest area was covered in the Altai region, where some especially interesting problems present themselves. It is a region in which since the close of Jurassic time certain earth movements have been in progress, warping the earth's crust so as to form alternate basins and domes or swells. From the higher ground sediment has washed down into the lower, and in these gravels, sands, and clays we occasionally find bones of extinct animals. The warping movements were renewed from time to time, and the most severe movements fractured the earth's crust along fault lines. On the uplifted side of the faults the rocks rose gradually by small, rudely rhythmic increments of movement until mountains—the Altai ranges—were made. On the downthrown side sediments continued to gather in increasing thickness, sheet upon sheet of sand, clay, and rock fragments washed down from the growing mountain. Volcanic outbursts along or near the fault fissures added floods of lava to the deposits in the basins. The map which covers this region includes bad lands, a study of desert drainage, salt lakes, lava flows, some lying horizontal and others upturned, two fault-block mountain masses, and two warped peneplanes. The scale is one inch to the mile, with 20-foot contours for the basins and 100-foot contours for the mountain blocks. The map covers about 700 square miles.

These are the four types of topographical record attempted in the field—the freehand sketch, the sketched route map, the compass survey, and the plane-table survey with telescopic alidade.

Lastly, the geologists are preparing summary maps of Mongolia as a whole on a small scale, recording in generalized form all the changes or corrections they feel justified in making in existing maps, as well as a summary of the known geology.

THE TWENTIETH ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

The Association of American Geographers met in Cincinnati on December 27–29, 1923, for the twentieth annual meeting. A joint meeting with Section E (Geology and Geography) of the American Association for the Advancement of Science brought together the adherents of both sciences. The meeting was held in the Old Technology Building of the University of Cincinnati, in the rooms of the Department of Geology. Of the thirty-one papers announced, twenty-three were presented and four were read by title.

In the field of cartography Professor J. Paul Goode of the University of Chicago presented his new world-projection in its final form. This consists of a welding together at 40° N. and 40° S. of Sanson's and Mollweide's projections, the former being used in the middle zone and the latter in the two poleward caps limited by those parallels. In addition, the net is interrupted along certain meridians north and south of the equator (40° W. north and 100° W., 20° W., and 80° E. south) to "ease" the cramped representation at the poles which characterizes Mollweide's projection in its usual form of a continuous, ellipse-bounded net for the whole world. There results a representation in which each continent is more or less balanced on its own central meridian. The same projection lends itself to a continuous representation of the oceans if the interrupting meridians be placed at 100° W. and 110° E. in the northern, and 70° W. and 140° E. in the southern hemisphere. This form of the projection was also presented.

Three papers dealt with meteorology and climatology. Professor R. DeC. Ward of Harvard University described the activities of the International Ice Patrol (see *Geogr. Rev.*, Vol. 14, 1924, pp. 50–61). The two other papers were an outgrowth of work done under Dr. C. F. Brooks of Clark University. Mr. George F. Howe (introduced) dealt with the summer and winter weather of selected cities of North America. Thirteen types of weather, derived from the combination of four classes of temperature, two of precipitation, and two of wind, were recognized. His maps showed the number of days for each city during which one of the established weather types prevailed. Mr. J. E. Switzer (introduced) spoke on "Weather Types in the Climate of Mexico." The steady warmth of the tropics (compare Professor Jefferson in *Geogr. Rev.*, Vol. 6, 1918, pp. 240–267) was brought out in a series of graphs of the daily temperatures of selected cities in Mexico.

Professor E. N. Transeau of Ohio State University discussed the plant geography of Ohio and illustrated the distribution of critical plants. Professor A. E. Waller of the same institution spoke on "Light as a Factor in the Distribution of Flax." Reporting that the answer was now available to the question he had raised at the fourth joint meeting of the American Geographical Society and the Association of American Geographers in April, 1920, as to the cause of the existence of a relict flora in Gaspé Peninsula, Quebec, Professor M. L. Fernald of Harvard University, in a paper entitled "The Flora of the Unglaciated Regions of Northwestern North America," stated the cause to be that that region had not been glaciated during the Ice Age. The botanical evidence was confirmed by the geological field work of Professor A. P. Coleman of the University of Toronto (compare F. J. Alcock's paper "Across Gaspé" in this number of the *Review*). Similar joint botanical and geological field work seems to indicate that the Long Range peninsula of Newfoundland likewise was not glaciated.

Nine papers were devoted to economic geography. Professor R. H. Whitbeck dealt with "The Ohio River as a Waterway." Mr. E. C. Case (introduced) of the Depart-

ment of Geology of the University of Cincinnati read a paper on "The Relation of Manufacturing to Natural Environment in the Valley of East Tennessee." Professor A. E. Parkins of the George Peabody College of Nashville described the recent growth in Southern cotton manufacture in a paper of that title and outlined the general conditions which favored the movement of cotton mills from New England to the South. Dr. Helen M. Strong of the University of Missouri read a paper, illustrated by graphs for the post-war period, on "The Geography of Our European Export Trade in Agricultural Products."

Two papers related to Canada. As a result of a field trip Professor C. C. Colby of the University of Chicago presented an excellent "Geographical Analysis of the Apple Industry in the Annapolis Valley, Nova Scotia," in which he discussed the climatic and locational advantages which have made this region the chief source of supply for Great Britain. Mr. Clarence F. Jones (introduced) of Clark University read a paper entitled "Railway Entrances and Terminal Facilities at Montreal" in which one of the routes of access he described dealt with the Canadian Northern Railway and the manner in which it overcame the topographic conditions in reaching the heart of the city.

Three papers dealt with Latin American topics. Mr. P. E. James (introduced) of the University of Michigan discussed the development of transportation in South America and illustrated his paper by maps of the continent showing the lines and means of communication at certain critical dates. Miss Alice Foster (introduced) of Mount Holyoke College gave a geographical interpretation of the cotton manufacturing industry in Orizaba, Mexico, based on a long sojourn in that country. Mr. F. A. Carlson (introduced) of the University of Ohio, Athens, Ohio, read a paper entitled "A Survey of Brazilian Agriculture." The paper was a result of work done in connection with an atlas of the agricultural geography of Brazil under preparation by the Brazilian Government.

Professor N. A. Bengtson of the University of Nebraska gave a sketch of the regional geography of the Santa Elena Peninsula, Ecuador, at the northern entrance to the Gulf of Guayaquil. The paper was illustrated by a large-scale physical map of the region, with altitude tints, based on original surveys. Professor W. M. Davis reported the results of his recent investigation of the Lesser Antilles, as a consequence of which he developed the concept and suggested the term of "marginal belt" for the poleward margins of the coral belt, in which, owing to the increasingly unfavorable conditions for coral growth, the coral islands have not always had the protection of an encircling reef. Dr. G. R. Mansfield of the U. S. Geological Survey gave a description of the various elements of the geography of southeastern Idaho. Professor Wellington D. Jones of the University of Chicago exhibited a map of a portion of Chicago classified into various types of districts as an illustration of the topic of his paper, "Field Mapping of Geographic Data." Professor S. S. Visher of the University of Indiana spoke on "Estimating the Comparative Richness of a State" and discussed the criteria that come into consideration. Professor N. M. Fenneman of the University of Cincinnati was unable to present his paper on "Some Geographic Problems in Australia" owing to the absorption of his time as a member of the local committee. To Professor Fenneman the Association and Section E are indebted for the excellent arrangements which characterized the sessions held in the congenial atmosphere of his department.

The whole of Friday, December 28, was devoted to joint sessions with Section E of the American Association for the Advancement of Science. In an address entitled "Seventy-Five Years of American Geology" the venerable dean of American geologists, Professor T. C. Chamberlin of the University of Chicago, gave a masterly review of the development of the science in this country during the lifetime of the Association. Professor Chamberlin's address dealt with the growth of our knowledge in that period as to the areal geology of the United States, the range of the geological column, the constitution of matter, the origin and composition of the earth. Professor W. M.

Davis gave a similar review, under the title of "The Development of Geography in the United States," of the growth of American geography since the colonial period. These two papers and the addresses of Professors Huntington and Shimer, mentioned below, will be published in *Science*.

After these two historical reviews Colonel C. H. Birdseye of the U. S. Geological Survey gave an account, illustrated by lantern slides, of his and his Survey party's recent boat trip down the Colorado River through the Grand Canyon (see this number of the *Review*, pp. 177-196).

Basing his remarks on his recent trip to the western Pacific Dr. Ellsworth Huntington in his presidential address, entitled "Geography and Natural Selection," cited mainly the cases of Australia and China to illustrate his theme.

The address of Professor H. W. Shimer, retiring president of Section E, on "Some Forces in Man's Social Evolution" was a lucid and masterful account of the social evolution of man as revealed by the development of our knowledge of biology, anthropology, and psychology.

A symposium held by the Ecological Society of America on the relation of general ecology to human ecology was of especial interest to geographers. The subjects dealt with were as follows: the relation of land and sea to organisms and to man; the relation of the atmosphere to plants, to animals, and to man; the relation of plant ecology through agriculture and horticulture to man; the relation of plant ecology through forestry to man; the relation of ecology to society and human behavior; the relation of nature to man as illustrated by the North American Indian.

During the last session of the Association of American Geographers Professor C. R. Dryer made some remarks on a review he is preparing of geographic education in the United States during the last hundred years. This is to appear in the *Annals* of the Association, together with a history of the Association during the twenty years of its existence, which has been prepared by Professor A. P. Brigham. At this meeting the Association was regretfully forced to cede to the desire of Professor Richard E. Dodge to withdraw from the office of secretary and editor to which he had been successively reëlected for many years. At the close of the session President Huntington voiced the universal sentiment of the members in expressing to Professor Dodge the Association's deep appreciation of all that he had done in promoting its welfare. To Professor Davis, its founder, and to Professor Dodge, its long-time secretary, the growth and development of the Association in the twenty years of its existence are in large measure due.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of January and February. The annual meeting of the American Geographical Society was held on January 22, at the Engineering Societies' Building, 29 West Thirty-ninth Street. After the reading of the annual reports and the election of officers for 1924 the Society was addressed by Sir Percy Sykes on "The Heart of Asia and the Roof of the World." Sir Percy has spent more than thirty years in Persia and Central Asia in various military and civil capacities. During this time he traveled extensively on the frontiers of India, Tibet, and Chinese Turkestan; he was the first European to cross the great Persian deserts in the footsteps of Marco Polo. At the regular monthly meeting held on February 26 a lecture illustrated by moving pictures was given by Mr. Horace D. Ashton on "A Caravan Journey into the Northern Sahara."

Elections to Fellowship. At the January meeting of the Society, President Greenough presiding, and the February meeting, Vice-President Henry presiding, there were presented with the approval of the Council the names of 121 candidates who were duly elected as Fellows.

Annual Reports of the Society. At the annual meeting of the American Geographical Society, held on January 22 at the Engineering Societies' Building, 29 West Thirty-ninth Street, the annual reports of the Council, of the Treasurer, and of the Special Committee were read as follows:

Report of the Council

New York, January 17, 1924

To the Fellows of the Society:

The year has been marked by substantial and gratifying advances in the Society's program of research and in the value of its publications, as well as their appreciation among scholars. First of all, mention should be made of the *Geographical Review*, the quarterly magazine of the Society, which forms the principal point of contact with the Fellows and with the scientific public. A large number of correspondents both at home and abroad testify to the high reputation and standing of the *Review*, and it is the purpose of the Society to maintain and extend its present distinction. The articles published in the four numbers of 1923 relate to almost every important division of the subject of geography, dealing with scenic features of outstanding interest, with recent discoveries and explorations by leaders in the field, with the economic geography of commercial frontiers, with the geography of densely populated districts and cities, such as Stockholm, Paris, Strasbourg, and the like, and with the geographical conditions that surround pioneer life in the thinly populated districts of the world. In the field of political geography there have been papers on boundary disputes and the history of boundary changes. Historical geography has had a part in our program, and physiography, oceanography, and climatology likewise. The demand for reprints of the leading articles and for copies of separate colored maps has been greater than ever, and we are convinced that the nature of the demand is such that our published material is a contribution toward the solution of many problems of outstanding interest today. While our aim is to publish a magazine of interest to a wide circle of lay readers as well as the scientific public, it is in no sense devoted to purely popular objects. It aims rather to make substantial contributions to knowledge and to publish these in a manner as attractive as the subject permits.

The monographs, special publications, and maps of the Society form a group of contributions both substantial and distinctive in character. During the year there have been published books and maps as follows:

Books

1. NEW YORK WALK BOOK. By Messrs. Torrey, Place, and Dickinson.

(A description of the scenery about New York and the roads and trails that provide access to open places. The book is in the general style of Dr. Dickinson's booklet on Palisades Interstate Park.)

2. THE LAND SYSTEMS OF MEXICO. By George McC. McBride.

(An intensive study of the use of the land and its geographical relations. It is now being translated into Spanish for wide distribution in Mexico under the auspices and by direction of the Government.)

3. THE VEGETATION AND SOILS OF AFRICA. By H. L. Shantz and C. F. Marbut.

(Illustrated by maps of the soils, vegetation, land classification, and rainfall of Africa, and published jointly with the National Research Council.)

4. AIDS TO GEOGRAPHICAL RESEARCH: BIBLIOGRAPHIES AND PERIODICALS. By John Kirtland Wright.

(Designed as an aid to research and locating published materials on a given subject.)

Maps

1. NEW YORK WALK BOOK MAPS.

(Eight maps in color on the scale of 1 inch to 2 miles reduced from the sheets of the United States Geological Survey with many corrections and additions. They cover the area dealt with in the text of the New York Walk Book.)

2. VEGETATION MAP OF AFRICA, 1:10,000,000 (about 32 miles to 1 inch). By H. L. Shantz.

(Accompanies "Vegetation and Soils of Africa." It shows vegetation, in color, and contains an inset on the scale of 1:25,000,000 by C. F. Marbut showing kinds of soil.)

3. LAND CLASSIFICATION OF AFRICA, 1:10,000,000 (about 32 miles to 1 inch). By H. L. Shantz and C. F. Marbut.

(Also accompanies "Vegetation and Soils of Africa." It shows agricultural potentiality and for what types of utilization each area is suited and the degree of potential productivity within each type. It contains an inset on the scale of 1:25,000,000 by J. B. Kincer of the U. S. Weather Bureau showing rainfall.)

4. BASE MAP OF HISPANIC AMERICA, 1:6,000,000 (about 70 miles to 1 inch).

(A black and white base map in three sheets compiled from over 200 sources.)

During 1923 one gold medal was awarded, the David Livingstone Centenary Medal to Professor Griffith Taylor of the University of Sydney, Australia. The distinguished work of Professor Griffith Taylor, of which this medal is a form of recognition, was described in the July number of the *Geographical Review*. It includes field work and monographs on the geography of Australia with particular reference to problems of rainfall and settlement and the economic geography of the unpopulated or thinly populated frontier regions of that continent.

The Society has made good progress upon its major plan of research in the field of Hispanic America. It has advanced the compilation of thirty-three sheets in a satisfactory manner and during the coming year will produce nearly a dozen sheets in

standard form, besides carrying well toward completion an equal number of other sheets in hand. Its aim has been to extend its operations on a broad front rather than to produce finished sheets to a maximum number. In this manner it avoids duplication in the arduous work of reference and compilation upon which the value of its map program so largely depends. It also enables the Society to secure an increasingly large number of original surveys from the files of commercial companies, exploring parties, and other private and hitherto unpublished sources. Associated with its map program is the compilation of a great index of maps of Hispanic America in which wide interest has been shown by research institutions, university departments of geography, and kindred societies in all parts of the world. It is with deep satisfaction that the Society records the approval of the National Research Council in this work of scholarship. At its annual meeting on April 18, 1923, the Division of Geology and Geography of the National Research Council, after expressing its interest in the furtherance of this work, adopted the following resolution:

"RESOLVED that the National Research Council regards the catalogue of Hispanic-American maps now in preparation by the American Geographical Society as a work of fundamental importance in relation to scientific research and urges its early completion and publication."

In addition it voted the sum of $600 as a contribution toward the expense of completing the catalogue, provided additional funds were secured; and this the Society has succeeded in doing. It is proposed to complete the catalogue in the course of the next few years and either to typewrite it in duplicate copies or photostat it, binding the results in seven or eight volumes, in a limited edition, to be sold at cost. It will contain references to all the maps, probably not less than 15,000 in number, which can be found by the committee of scholars in charge and will, we hope, form a standard work of reference for many years to come.

The Society has continued its cordial relations with the Association of American Geographers and maintains the policy, begun years ago, of sending the *Geographical Review*, free of charge, to members of the Association, thereby placing within reach of every member of the Association the latest and most authoritative comment upon the progress of geographical knowledge throughout the world.

The Society has followed its former custom of sending representatives to important scientific gatherings and occasions of special geographical interest. On November 19, 1923, on the invitation of the Academic Council of the University of La Plata, Mr. Willing Spencer, Counselor of the American Embassy at Buenos Aires, represented the Society at the unveiling of a memorial to Dr. Francisco P. Moreno. Dr. Moreno was awarded the Cullum Geographical Medal of the American Geographical Society in 1909 in recognition of his distinguished work in surveying the lake region of Patagonia and of his cartographic researches and field work in the plateau country of the Puna de Atacama in northwestern Argentina.

On the invitation of the officers of the Australian National Research Council the Society appointed two representatives, Mr. A. H. Brooks, of the U. S. Geological Survey, and Professor N. M. Fenneman, of the University of Cincinnati, to represent it at the sessions of the Pan-Pacific Science Congress held in August and September, 1923, at Melbourne and Sydney. It was during one of the general sessions of the Congress held at Sydney that Professor Griffith Taylor was presented with the David Livingstone Centenary Medal of the Society by one of our representatives. The Congress was well attended by American geographers and marked an important step in the organization of geographical knowledge and field work in the Pacific realm.

In addition, President Greenough represented the Society on the occasion of the inauguration ceremonies of Samuel Wesley Stratton as the President of the Massachusetts Institute of Technology on June 11, 1923; and the Director of the Society represented it on February 3, 1923, at a meeting at the United States National Mu-

seum in commemoration of the one hundredth anniversary of the birth of Spencer Fullerton Baird, former Secretary of the Smithsonian Institution.

Additions to the library during the year comprise 1267 books, 474 pamphlets, 6375 periodicals, 4185 maps, 117 atlases. The collection now numbers 63,945 volumes of books and pamphlets and 61,530 atlases and maps. Mr. Francis Burton Harrison, former Governor-General of the Philippines, has presented to the Society 513 books and periodicals, 551 maps, and 18 atlases dealing primarily with military events in Europe in the eighteenth and early nineteenth centuries. These form a valuable collection of source materials not only for the history of the campaigns of the Seven Years' War and the Wars of the French Revolution and of Napoleon but also for the history of cartography. To supplement the dictionary catalogue of the Society's library a new catalogue was begun in February, 1923. This is a class catalogue, designed especially as an aid to the research worker. In it are filed cards referring to all books and to all important geographical articles in serials received. The cards are arranged by topics and by regions with a view toward enabling the consultant to find grouped together in one place references to all important publications dealing with the particular subject of his investigations. An important feature is a series of maps which serves as a key to the regional arrangement of the cards.

The lectures of the Society have been well attended and appreciated. The speakers have been as follows:

The Reverend Hugh Birckhead, "Palestine, the Shrine of Three Great World Religions;" Captain Kilroy Harris, "Through Unknown Australia;" T. Alexander Barns, "The Eastern Congo and the Land of the Giant Craters;" Carveth Wells, "My Six Years in the Jungle of Malay;" Lieut.-Col. William Warfield, "An Intimate View of the Balkans;" Major E. Alexander Powell, "By Camel and Car to the Peacock Throne;" Roy Chapman Andrews, "The Third Asiatic Expedition."

The preparation for the active prosecution of work in the School of Surveying is now complete. All the requisite instruments of the latest and best character are made available, and instruction will be given by Messrs. O. M. Miller and Weld Arnold, who received their training in the School of the Royal Geographical Society at London and hold diplomas from that institution. It is believed that this school now inaugurated by the Society will open an opportunity for practical training which is not afforded by any other existing institution in the country. The attention of the leading universities has been called to the facilities offered, and they have been invited to direct the attention of suitable students to the new opportunities presented.

The number of Fellows at the close of the year was 4117, of whom 408 are Life Fellows. In addition there are eight Honorary and thirty-five Corresponding Fellows.

The report of the Treasurer submitted herewith gives a condensed balance sheet and a summary of the income and expenses of the Society.

PHILIP W. HENRY
Chairman

REPORT OF THE TREASURER FOR 1923

Receipts and Expenses

During the year there has been received from annual dues, interest on investments, and sales of publications	$68,626.52
There has been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	77,634.36
Balance charged against Special Deposit Fund	$9,007.84

Condensed Balance Sheet, December 31, 1923

Cash	$17,327.58
Sundry balances and investments	100,532.20
	$117,859.78
Capital Account, Balance uninvested	$2,610.57
Annual dues paid in advance	2,129.75
Special Fund for general purposes	90,992.16
Sundry deposits and reserves	18,350.86
Monograph Publication Fund, Balance	1,930.41
Hispanic-American Research Fund, Balance	1,846.03
	$117,859.78

HENRY PARISH
Treasurer

REPORT OF THE SPECIAL COMMITTEE

The Special Committee appointed December 13, 1923, to nominate and invite suitable persons to fill vacancies which will occur in the offices of the Society at the date of its annual meeting in January, 1924, respectfully report that they recommend the election of the following gentlemen to the office designated:

		Term to expire in
President	John Greenough	January, 1925
Vice-President	Alexander Hamilton Rice, M.D.	January, 1927
Foreign Corresponding Secretary	Professor William Libbey	January, 1927
Treasurer	Henry Parish	January, 1925
Councilors	Banyer Clarkson Edwin Swift Balch H. Stuart Hotchkiss Walter B. James, M.D. Frederick W. Walcott	January, 1927

Philip W. Henry
Roland L. Redmond
Hamilton Fish Kean
Committee

GEOGRAPHICAL RECORD

NORTH AMERICA

A Fault Map of California. "Earthquakes are still strange phenomena, for we have been too much afraid of them to become intimate with their causes." Thus Bailey Willis prefaces the explanatory paper accompanying the recently published "Fault Map of California" (*Bull. Seismol. Soc. of Amer.*, Vol. 13, 1923, pp. 1–12). The map is designed as a "contribution to the security of the people of the Commonwealth" by calling attention to natural conditions "in which there is an element of danger, but that danger is greatly exaggerated by ignorance and intensified by negligence." Its primary purpose is to indicate the location of faults which may give rise to earthquakes.

The map was compiled in 1922 by the Seismological Society of America in cooperation with the Hydrographic Office, Navy Department, the United States Geological Survey, the Carnegie Institution of Washington, the University of California, and Stanford University. The scale is 1: 506,880, or eight miles to the inch. The four component sheets (one bearing the title) mounted together make a wall map approximately seven feet high by six feet wide. Residents of California will find the map of considerable general value aside from its connection with the problem of earthquakes. The large scale has made it possible to show geographic details without confused crowding. Addition of the land net is a useful feature. The map is made especially attractive and usable by representation of the varied topography of the state done by John H. Renshawe, whose work in relief shading has attracted much notice for several years.

Bailey Willis and H. O. Wood are the authorities for location and character of faults, which are distinguished as "active" and "dead," represented respectively by red lines and green. Unfortunately, a uniform basis for the classification was not adopted. Mr. Wood, working in the southern part of the state, mapped in red the faults on which there has been movement within historic time and also those on which "trace" phenomena could be seen. Mr. Willis interpreted as "active" any fault apparently related to a growing mountain and took as one of his criteria the obvious displacement of an old erosion surface, whether or not the fault exhibits "trace" phenomena or has been known to move within historic time. Presumably, therefore, if the interpretation of Mr. Willis is adopted, the map gives a less complete representation of "active" faults south of San Luis Obispo than north of that point. Without doubt considerable inference and generalization was used, particularly in representing the "dead" faults; and the assurance as to location expressed by use of the full line may be questioned locally.

The outstanding fault feature is of course the great San Andreas rift, with its numerous branches. Comparison of the present map with the atlas compiled by the Earthquake Commission after the earthquake of 1906 (Carnegie Institution of Washington, 1908) suggests the great strides made in the study of the rift during recent years. There are noticeable differences in the location of the main trace on the two maps, and the rift is now shown as a complex feature, with many branches and small associated faults, in contrast to the simple line drawn in the atlas of 1908. North of Lagunitas the rift trace is now shown as forking, to straddle Tomales Bay. Except for a few small faults indicated as "dead" and uncertainly located, no lines are shown on the present map north of the latitude of Ukiah. Thus a number of large faults indicated on the older map in Humboldt and neighboring counties have been entirely omitted. No direct explanation of the omission is made, although

Mr. Willis presents the map as a statement of progress and therefore incomplete. It is to be assumed, therefore, that faults north of the 39th parallel are too imperfectly known to be represented satisfactorily.

Another striking difference between the two maps is seen in the relation of structure lines east and south of the Sierra Nevada block. In the atlas of 1908 a continuous curving fault trace is shown bounding the range on the east and south and joining the San Andreas rift near Gorman. More recently the structure of that region has been studied by Hess, Buwalda, and others, and the new map shows the main fault south of the range continuing eastward through the structural depression mentioned by Gregory and Noble as the Leach Trough (*Amer. Journ. of Sci.*, No. 205, Ser. 5, Vol. 5, 1923, pp. 229–238). Renshawe's shading brings out strikingly the abrupt regional change in topography at the fault, emphasizing the suggestion made by Gregory and Noble that this is a structure line of major importance.

The map has numerous features that inspire speculation, particularly in the field of structural geology. South of the latitude of San Francisco underwater contours, with an interval of 100 fathoms, are shown to a depth of 2000 fathoms. This contouring is based on work done by use of the new Sonic Depth Finder. The results, which are more graphically exhibited by bathymetric tints on Hydrographic Office Chart 5194, suggest a promising field of investigation. With a contour interval as large as 100 fathoms any practical study is impossible, for no doubt the most significant details are obscured. Even so the San Clemente and Santa Catalina blocks are sharply defined, and steep slopes elsewhere suggest the influence of faulting in determining the submarine topography. The canyon-like trough heading in Monterey Bay is represented as continuing oceanward to a depth of 12,000 feet! Doubtless many more data for ascertaining the significance of such features will be furnished in the near future, with extended use of the Sonic Finder.

CHESTER R. LONGWELL

The Distribution of Agricultural Exports from the United States. Agricultural produce still constitutes the major item in the export trade of the United States. For five pre-war years, 1910–1914, it averaged 48 per cent of the total; 50 per cent for 1922. A useful service has been performed by the Department of Commerce in analyzing the distribution of this export, a new statistical departure. A general survey is given in *Trade Information Bulletin No. 177*, and further details are promised in forthcoming bulletins. Products are classed in ten commodity groups—live animals, meats, animal fats and oils, bread grains (wheat and rye), coarse grains (barley, buckwheat, corn, and oats), fodders and feeds, fruits, sugar, tobacco, cotton. Comparison is made between the five pre-war years and 1920–1922.

As regards commodities the most striking change is in the relative proportions of cotton and bread grains. Cotton has dropped from 54 per cent to 32 per cent, in actual amount from 4,500,000,000 pounds to 3,250,000,000. Decline in home production has been concomitant with economic depression in the importing countries: only two, Italy and Japan, have exceeded their pre-war imports. The seriousness of this particular phase of the agricultural problem is reflected in the numerous investigations for increasing the world's supply (see, e. g., J. A. Todd: The World's Crisis in Cotton, *Foreign Affairs*, December, 1923). The bread grains increased from 10 per cent to 26 per cent (in actual amount the total of grains exported rose from 10,000,000,000 pounds to 25,000,000,000 pounds). This great gain is due primarily to the disappearance of the United States' chief competitor, Russia, to the decline of production elsewhere in Europe, and to the small crops in India in 1919 and 1920. Meats and related products have changed little in relative proportion; sugar has increased with the decline of beet sugar exports from Germany and Russia; tobacco also has increased.

As regards destination it may be said that in round numbers Europe takes four-fifths of the food exports of the United States; and of this, four-fifths again goes to the industrial region of the northwest—the United Kingdom, Germany, France, the Netherlands, Belgium—more than half to the United Kingdom (33 per cent of the total to all countries). Among changes in destination we may note the decline for Europe as a whole from 84 per cent to 77 per cent, Germany's former import of 25 per cent being cut to 14 per cent. Export to North America has risen from 10 per cent to 13 per cent; to Asia from 3.5 to nearly 7. The last may be considered indicative of a trend toward the development of a large future market for foodstuffs in Eastern Asia.

Inland Water Transportation in the United States. Under this title the Department of Commerce (*Bur. of Foreign and Domestic Commerce Misc. Ser. No. 119*, 1923) presents a critical study of the inland waterways situation in all its phases. Except for the Great Lakes, the Ohio River, and a few short routes where natural conditions and industrial development have been particularly favorable, the decline of waterway transportation has followed closely upon railroad development; so closely, in fact, that by 1895—although in the period from 1882 to 1895 New York state, for instance, had spent $125,000,000 upon the development of her waterway—those waterways had been reduced to a relatively unimportant position. It is true that much of the decline of water transportation was due to ruinous rate cutting on the part of competing railroads. This has been largely checked by prohibitions incorporated in the Interstate Commerce Act of 1887 and the Mann-Elkins Act of 1910 which amended the act of 1887. The fact remains, however, that by far the greatest cause for the decline of water transportation is due to the greater flexibility of the railroad system, to the standardization of gauge whereby transferring was largely eliminated even at receiving termini, to the greater speed and the possibility of day-and-night and year-round traffic, to greater carrying capacity of the double track road as compared with canals, to the ability to adjust the size of the train to the load and thereby reduce running costs. Of almost equal influence is the fact that, with the exception of the Great Lakes and the Ohio River, the waterways of the country do not parallel the great transportation routes. The auto truck should also be noted as a competing transportation agency of growing importance.

The factors in the problem, therefore, are many, and the eliminating of any one will not bring about a general revival of waterway traffic. Each case is a separate problem. Greater industrial concentration in certain regions may tax railway facilities to the point where waterways must be developed to lighten the congestion. The present rapid strides in the industrialization of the South and increased trade with South and Central America may give renewed prominence to the great north-and-south water routes which have been eclipsed by the trend of traffic to the Atlantic seaboard.

Variation in the Annual Discharge of Rocky Mountain Streams. Two factors contribute to the wide variation in annual run-off shown by the streams of the Rocky Mountain states (Robert Follansbee: Variation in the Annual Run-Off in the Rocky Mountain Region, *U. S. Geol. Survey Water-Supply Paper 520–A*, Washington, D. C., 1923). The influence of topography is evidenced by the fact that streams rising in the central mountain mass have a smaller range in variation than steams which rise on either the eastern or western edge of this central mountain region. Also, precipitation in any part of the mountain region depends upon the point at which the low-pressure areas cross; but, inasmuch as well-known low-pressure paths which cross the Rockies have rather wide limits, there are great

variations in precipitation and run-off throughout the mountain region in any one year and from year to year in any one section. This variation is of three sorts: the variation from year to year in any particular region; the variation among the different regions for any one year; and the variation from year to year in the relationship of the run-off in any particular region to the mean run-off for the whole Rocky Mountain region over the entire period of record (over 30 years for many stations). For instance, the lowest record, except for drainage basins in northern Montana, for the entire period covered by records occurred in 1902; and the run-off for the South Platte, Arkansas, and Rio Grande was below normal during the nineties and above normal since 1903, while the Cache la Poudre basin had low water during the eighties, high water up to 1905, and low water since then. In fact the ratio of any ten-year mean to the mean for the entire period covered by records ranges from 72 to 133 per cent. The annual run-off for streams rising in the plains east of the mountain region also varies greatly, but the records show no definite relation between precipitation and run-off. Rather, so great is the demand upon the moisture supply in the plains by transpiration of plants, evaporation, and percolation that the run-off in plains streams is governed not so much by total precipitation as by intensity. In one day in 1920 the run-off of the Cheyenne River was greater than that for the whole year of 1916 or 1919.

Erosion and Deposition in the Desert Southwest. Two conspicuous features of many arid regions are long gentle slopes, *bajadas*, extending from the base of the mountains or range of hills to the main longitudinal stream valleys or to the lake-like playas and terraces. Minor features are dunes, "desert pavements," and "pedestal rocks." Each of these features has been discussed by eminent geologists including McGee, Walther, Davis, Barrell, and Lawson, but there have been radical differences of opinion expressed thereon. Recently, however, much new light has been thrown on their origin by Dr. Kirk Bryan, of the U. S. Geological Survey, in an able discussion of their occurrence and development in southwestern Arizona. ("Erosion and Sedimentation in the Papago Country, Arizona, with a Sketch of the Geology," *U. S. Geol. Surv. Bull. 730–B*, 1922; "Wind Erosion near Lees Ferry, Arizona," *Amer. Journ. of Sci.*, No. 206, Ser. 5, Vol. 6, 1923, pp. 291–307; and "Pedestal Rocks in the Arid Southwest," *U. S. Geol. Surv. Bull. 760–A*, 1923.)

The long slopes, or *bajadas*, have two distinct phases: (1) the rock plain, named by Bryan the "pediment," and (2) the detrital or alluvial fans. Detrital materials commonly cover all but the one to three miles nearest the mountains, the thickness of the detritus increasing to the center of the *bolsón*, or great valley, where it may be hundreds of feet thick. The pediment has been ascribed to wind action by Keyes and to the retreat from the fault scarp, but Bryan believes with Lawson that it is a normal feature of arid regions studded with mountains.

Alternation of erosion and deposition is common in deserts, and hence terraces are conspicuous in many places. Davis has related these to the normal geographic cycle. Huntington, Barrell, and Visher have concluded that the climatic changes associated with glaciation probably were related to certain changes in erosion and deposition in Central Asia and Arizona. Recent terracing along the Santa Cruz Valley near Tucson was ascribed by Huntington (The Climatic Factor as Illustrated in Arid America, 1914) to recent changes of climate. From a study of tree rings he advanced the hypothesis that about 1700 the climate was considerably wetter than now. These conclusions have been considered unsound by some critics; but recent evidence, Dr. Bryan concludes, effectively supports the hypothesis. Part of the evidence is based on the recently published memoir of Father Kino who spent several years in the area about 1700 and who gave estimates of the population and irrigated land in different areas.

Dr. Bryan, in the shorter papers referred to, concludes that although wind erosion and transportation are physiographically very important in certain arid localities, in others they are insignificant. Many pedestal rocks in the southwest, commonly ascribed to wind work, are apparently the result of weathering, no clear evidence of wind erosion having been found. Likewise the frequently mentioned desert pavement is believed to be due in many places to run-off rather than to wind work, for the removal by either agency of fine materials from a gravelly sediment results in the development of a surface layer of pebbles. Furthermore, typical pavements occur where other evidences of wind work are lacking, but where the results of run-off are conspicuous. In brief, Bryan's studies have led him to conclude that running water is the chief erosive agency in nearly all parts of the southwest. Only in regions receiving less than five inches of rainfall a year and also in areas where, because of porous rocks, there is a little run-off, does the wind surpass running water as an erosive agent.

STEPHEN S. VISHER

The First Separate Map of Pennsylvania. By an important discovery Mr. Worthington C. Ford has recently identified what is probably the first separate map of Pennsylvania (see *Proc. Mass. Hist. Soc.*, Vol. 57, 1923–1924, pp. 172–181). In an eight-page tract issued by William Penn in 1681, having as its caption title "A brief Account of the Province of Pennsylvania . . . ," reference is made in a postscript to a printed "*Map of Pennsylvania*, together with a Description at the End of it." Before Mr. Ford's investigation no map had been positively identified as the one referred to in this postscript. Thomas Holme's map (see P. L. Phillips: A List of Maps of America in the Library of Congress, Washington, 1901, p. 670) was commonly supposed to have been begun in 1681, but Mr. Ford shows that it cannot have been the map mentioned in the Penn tract because it represents "a situation that must have existed later than 1681."

While examining a volume of manuscripts and printed maps in the John Carter Brown library, Mr. Ford came across "a printed map of Pennsylvania with the endorsement 'With a description' in manuscript, the very words used in *A brief Account*." "Pasted to the bottom edge of the map" he found "a statement printed in four columns, which, without a caption, is *the* description required." The map itself was one that was sold by Thornton and Seller and of which there is a copy in the Library of Congress. Phillips (*loc. cit.*) had conjectured that the date of Thornton and Seller's map was 1683, but Mr. Ford's discovery shows that it must have dated from 1681. The map "runs from New Jersey, but the detail, except for an abandoned Indian fort, called Susquehannah fort, and names on the west shore of Chesapeake Bay, ceases with the Susquehannah River. Thus only some sixty miles to the west of the New Jersey line and some eighty-two miles from north to south are given with names. The designer or engraver has sprinkled hills and trees in the unoccupied spaces, each tree being named." In various respects the map differs from that of Holme. Unlike the latter, which "is frankly extended to show the location of Philadelphia, how the place was laid out and the grants of land made to individuals," "the map of 1681 was in anticipation of settlement, showing neither Philadelphia nor its proposed site and sparing such detail as crowds the Holme map."

The text of the "Description" (given in Mr. Ford's paper) "is that of *A brief Account* shortened and modified to suit the smaller space of the form of printing." The country, its produce and inhabitants, conditions of settlement, and persons fittest for plantations are briefly discussed, and recommendations are given for the journey and in regard to what should be first done on arrival. The southerly latitude of the region in comparison with that of England is commented upon, but it is added: "The Air is generally clear and sweet, the *Summer* is longer and Hot-

ter, and *Winter* shorter and Colder than in *England:* The Soil is said to be as good as any in those parts." The capabilities of the country are estimated optimistically: "It is thought by several knowing Persons, that have Travelled those parts of *America*, and have been well acquainted with places in *Europe* of the same degree, that there may be *Silke, and Wine*, if not *Oyle;* and for *Flax, Hemp, Woad, Madder, Liquorish, Potashes, and Iron*, there needs to be no question." In conclusion the remark is made that "it seems to many, to be the time wherein those desolate Western parts of the World are to be Planted, and have their day, as *Asia, Africa*, and *Europe* have had, (of which there are divers prouisees extant) yet let all have a Reverend regard to Gods Providence in their removal, and be serious in it, rather seeking the comforts of retirement, and sufficiency for Life (like the blessed Patriarks of Old,) then ease, fulness and wealth. . . . "

EUROPE

The Forests of Northern European Russia. It seems inevitable that in the near future the industrial nations of northwestern Europe will be obliged to draw their supplies of soft wood to a large extent from the immense and almost untouched forests of northern Russia. The resources of Scandinavia and the Baltic states are barely sufficient to meet the demands now placed upon them. Hitherto the United States and Canada have exported great quantities of timber and its products to Europe, but the United States will soon be eliminated. During the next half century most of the Canadian exports will find their way southward to satisfy our ever increasing demand. Britain, France, and Germany will have to seek in Russia the timber they formerly received from North America.

E. P. Stebbing, professor of forestry at the University of Edinburgh, visited Russia in 1917 in order to investigate on the ground the northern forests and to determine through conversations with members of the Provisional Government, then in power, the most satisfactory measures toward rendering the resources of these forests available to Great Britain at the lowest cost. He discussed his investigations and certain general recommendations based upon them in a paper read before the Royal Society of Arts in March, 1923 ("The Forests of North Russia and Their Economic Importance," *Journ. Royal Soc. of Arts*, Vol. 71, 1923, pp. 416–429). His recommendations envisage the obtaining by Great Britain—when the political situation in Russia permits—of concessions of half a million acres of forest land in the Olonets government, of a million or a million and a half in the Vologda government, and of a million acres in the Ob forest area to the east of the Ural Mountains. On her part, Russia will find a ready means toward economic rehabilitation if she permits the exploitation of her forests through foreign capital. Work could be started in the forests without delay, whereas much time must elapse before agriculture and industry can be revived to a condition of large-scale productivity.

From the geographical point of view, Professor Stebbing's paper and an earlier one by him ("The Forest Region of North-East Russia and Its Importance to Great Britain," *Geogr. Journ.*, Vol. 51, 1918, pp. 359–374) present the latest available account in English of the forests and forest life of a region very little known to the western world.

With the exception of the tundras along the Arctic coast, the whole of northern European Russia is forested. "The forests in the Olonets Government [the vicinity of Lake Onega] contain small trees for the most part, serviceable for wood pulp manufacture." Vaster virgin forests lie to the eastward in the Vologda and Archangel governments. The valleys of the Mezen and Petchora Rivers "contain fine forests without a doubt, especially the former;" but of all this region,

both in the wealth of the timber resources available and in the facility of communications the most promising tracts lie in the basin of the Vichegda.

The town of Ust Sisolsk, on the Vichegda 400 miles above its confluence with the Dvina, is in the center of a district "which contains nearly 36,000,000 acres of forest [slightly less than the area of Michigan], some of it reported by those who were in the best position to know, to contain as fine timber as was to be found anywhere else in Russia. Already, although but a fringe had been tapped, over half a million logs were floated down the river yearly from Ust Sisolsk, in addition to those brought out down the tributaries between that town and Kotlas." The logs are sent down the smaller streams singly; on reaching the larger rivers they are made into rafts which are easily piloted down the Vichegda and Dvina to Archangel.

The sparse population of the Vichegda basin is composed for the most part of Zyryans (see map in this number of the *Review*, p. 271), "a light-hearted, singing people, fond of bright colours in dress, and very different from the dull, stolid North Russian peasant." These folk speak a language of their own—a mixture of Russian and Samoyed—and dwell in villages scattered along the thin ribbons of cultivated land that fringe the rivers. Back of these narrow strips the forest prevails, uninhabited except in the winter. Only through the combination of summer work on their fields and of winter work in the woods are the natives able to "continue to inhabit these regions under modern conditions of life, primitive as they still are in these parts."

The Kola Peninsula. The Murman Railway, which has given Russia the use of a new ice-free port, has also opened a great stretch of almost unpopulated country to exploitation and settlement; but without local population, production, and trade it is safe to say that this whole enterprise must remain unprofitable and insecure for the nation. To investigate the possibilities of the region, and especially of the Kola Peninsula, which forms the hinterland of the Murman Coast, the Northern Scientific-Industrial Expedition was despatched in 1920, including a soil and botanical detachment from the Geographical Institute of Petrograd. The findings of this detachment are embodied in six reports, three of which have so far come to hand.

It must be admitted that the conditions described in these reports hold out little hope as to utilization of the soil of the region. Its topography presents the characteristics of recent glaciation, with a thick deposit of glacial drift almost entirely covering the bed rock of crystalline schist. The climate is subarctic, with about four months of temperate weather and with slight rainfall. The vegetal associations of the interior are mainly those of the temperate zone—pine, fir, and birch forest and sphagnum swamp. The latter merges into arctic tundra, the report on which is not yet available. The investigators appear, however, to use this term in a very restricted sense; for Professor G. I. Anufriev, in his report on swamps, describes a formation in which hummocks retain cores of ice the year round as "transitional." He writes, with regard to previous studies of arctic vegetation, "the greater part of the work done bears mainly upon the purely tundra formations, neglecting the forest zone adjoining them on the south: . . . this must, unfortunately, be said to apply even more strikingly to the swamps." His report indicates few possibilities of exploitation. The peat of these northern swamps is not even suitable as fuel, owing to insufficient decomposition. The most practical suggestion is that of their conversion into forest by drainage.

The two associations noted give rise to two main types of soil: the peat of the swamps and the *podzol* of the forests, the latter of which is interestingly described by E. A. Marcus. Neither is susceptible of cultivation in its existing state, be-

cause of extreme acidity due to the total absence of limey soils. Professor Sukachev, in his introductory report on general problems, makes the observation: "There is no doubt that the question must soon be faced of developing by selection new races of cultivated plants adapted to the conditions of the far north." But there seems little immediate prospect of any utilization of the soil of the Kola Peninsula otherwise than through forestry.

J. V. FULLER

Postglacial Changes in European Russia According to the Present Distribution of Birds. Under this title, V. V. Stanchinski publishes, in the 1922 number of *Izvestia*, of the Geographical Institute, a preliminary account of the present distribution of birds in Russia as affected by past conditions. Noting that many species of swamp and forest birds of other regions are not now to be found in central Russia, despite favorable conditions, and that they even avoid the region in migratory flight, the writer seeks an explanation for their absence in the former existence of conditions unfavorable to their spread. In his classification of the kinds of frontiers limiting the spread of species, he includes a category of "relict" frontiers, determined by conditions which have changed so recently that their effects have not yet been overcome by the more slowly spreading species. With respect to numerous swamp and forest birds, such a "relict" frontier appears to exist round the region of central Russia extending roughly from the Vistula on the west to the Volga on the east and from a line through Kiev on the south to a line through Novgorod and skirting the Baltic on the north. Within these frontiers, the writer concludes, there must have been "in postglacial times, a rather lengthy period during which swamp, water, and forest birds could not spread into central Russia."

Such desert conditions could hardly have followed immediately upon the withdrawal of the ice. Moreover, various species of tundra and woodland birds are found to migrate across the region, although conditions of life there are not now favorable for them. From this fact and from the writer's assumption that "every migratory route must . . . be considered as . . . retracing the spreading of the species" the conclusion follows that, in past times, favorable conditions did exist. These would naturally have intervened between the glacial and desert periods. The further supposition of a transitional period between the desert and the swamp forest of the present time is borne out by the particular rarity of birds requiring swampy conditions, even in such favorable regions as the Novgorod and Kostroma governments.

On the basis of these deductions the writer outlines the following succession of postglacial periods in central Russia: "(1) Lake-tundra (arctic); (2) Meadow-forest (birch-aspen woodland); (3) Desert-steppe (central Russian desert); (4) Forest-steppe; (5) Forest (*taiga*)." While such a reconstruction of postglacial changes can hardly be taken as established by this one line of investigation, the possibilities should tempt further inquiry.

J. V. FULLER

The Gradual Filling In of the Crater of Vesuvius. After the eruption of 1906 the crater of Vesuvius measured some 700 meters in depth and 720 meters in width along the major axis. Since that time the depth has been diminished considerably more than half by a gradual process of filling in. The successive stages in this process have been carefully observed and measured by Italian scientists and are discussed (to 1921) in a paper read by Professor Alessandro Malladra before the Eighth Italian Geographical Congress at Florence, 1921 ("Sul graduale riempimento del cratere del Vesuvio," *Atti VIII Congresso Geografico Italiano*, Vol. 2,

Florence, 1923, pp. 67–75). Figure 1 reproduces on a smaller scale an idealized cross section which accompanies Professor Malladra's paper and illustrates graphically the chronological sequence of events.

The filling up process until 1920 may be divided into two phases. During the first phase, which lasted until 1911, strictly volcanic activity was dormant. Landslides from the over-steepened walls were continuously pouring loose materials into the funnel-shaped crater until the latter was reduced to a maximum depth of some 300 meters. Between 1911 and 1913 the topography of the floor of the crater "underwent notable changes in form and oscillations in altitude." Whereas ma-

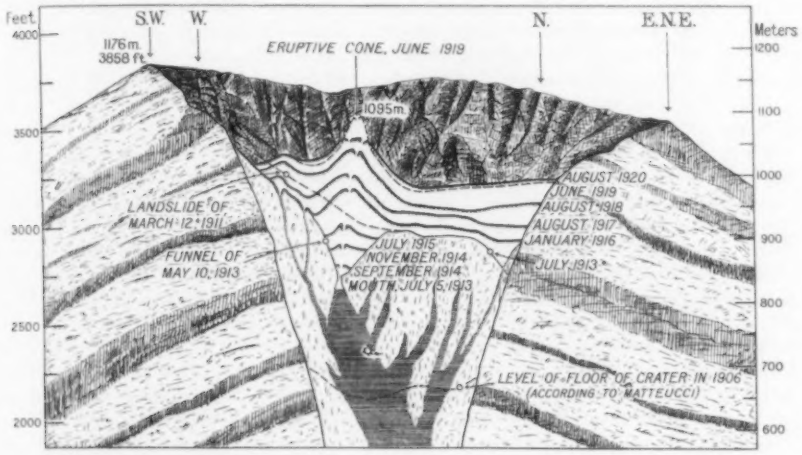


FIG. 1—Crater of Vesuvius. Ideal cross section passing through the eruptive cone showing successive phases in the filling in of the crater from 1906 to August, 1920. After A. Malladra.

terials from the landslides were still being contributed from above, volcanic activity was manifest in the depths of the mountain. The unconsolidated deposits immediately beneath the crater were being melted by contact with uprising magmas, and their resulting loss of volume produced subterranean caverns. When the roofs of these caverns collapsed, folds and funnel-shaped hollows appeared on the surface of the crater floor. On July 5, 1913, molten lava actually came to light at the bottom of the deepest of these hollows, forming what the Italians style a "mouth of fire" (*bocca di fuoco*).

This event ushered in the second phase, one of active volcanism. Since 1913 there has been an intermittent building up of the crater floor by successive flows of lava and dispersals of volcanic *ejecta* at times of more pronounced activity. Outpourings of lava, however, have contributed the greater quantity of material. Some of the lava has found its way to the surface through lesser channels and fissures, but by far the larger part has been derived from the "mouth of fire" which originated on July 5, 1913. When a semi-liquid substance wells up vertically from an aperture and hardens rapidly, as does lava, there is a tendency toward the building of a cone around the aperture. The main eruptive cone of Vesuvius grew almost vertically until a maximum altitude was reached in June, 1919. In addition to this main cone, secondary cones have grown to lesser heights around apertures of secondary importance.

Vesuvius has been active since the period covered by Professor Malladra's paper. The eruptive cones, especially the principal one, have been materially modified

in form and height. For example, in October, 1921, the main cone was observed to have been split open and a great mass of lava to have issued forth and covered practically the entire floor of the crater. On March 12, 1922, the height of the main cone was about 80 meters: by May 18, 1922, it had been reduced to 25 meters. The general level of lava accumulations in the crater has also been progressively raised by continued fresh flows (see R. Zünckel: Beobachtungen im Vesuvkrater, *Zeitschr. für Vulkanologie*, Vol. 6, 1922, pp. 258–261).

Recent Investigations of the Currents of the Western Mediterranean. A widespread belief has prevailed that a fairly steady current (known by the Italians as the *litorale mediterranea*) moves in a northwesterly direction along the west coast of Italy. This belief has even found its way into navigation manuals. Experiments carried out by Professors G. Dainelli, O. Marinelli, and G. Stefanini in 1909–1910 and by Professors Baldasseroni and G. Stefanini in 1919–1920 have shown that the conception is misleading.

The method of experimentation was one that has often been employed in oceanographical research. Bottles were thrown into the sea a few miles offshore near Leghorn. Each bottle contained a blank form which the finder was requested to mail back to the investigators after he had filled in the date and place where the bottle was found. Of 127 such bottles employed in 1909–1910 no less than 75, or 59 per cent, were recovered. In 1919–1920 340 bottles were used, but only 97, or 29 per cent, of these were heard from. In each case a few bottles at a time were set afloat at intervals throughout an entire year, in order to determine the variations in currents from season to season.

The researches of both 1909–1910 and 1919–1920 tended to show that during the winter half-year there is generally a counterclockwise movement of the waters of the western Mediterranean, governed by the winds flowing towards an area of low barometric pressure prevalent there at that time of year. On the other hand, the conclusions drawn from the two sets of experiments for the summer half-year were not the same. The observations of 1910 indicated a distinct reversal in the direction of the drift, but those of 1920 gave no such evidence: they showed that the seasonal uniformity (for that particular year, at any rate) was much less marked. Most of the bottles in 1919 were found either off the coast or along the Italian seashore north of Castiglioncello where they were launched. Some, however, were carried to the shores of France, Spain, the Balearic Isles, and even Algeria and Tunisia.

Though the experimenters do not maintain that their work has resulted in a definitive understanding of the problem, both sets of experiments have shown that the movements of water in the western basin of the Mediterranean are extremely variable, changing in direction and velocity with the changes of the winds. There is certainly no well defined, perennial current corresponding to the older conception of the *litorale*. (See *Materiali per la conoscenza del Mediterraneo IV: Esperienze sulle correnti nel Tirreno, Memorie Geogr.* (Suppl. to *Riv. Geogr. Italiana*) *No. 22* (= Vol. 7, pp. 195–241), Florence, 1913, and *Atti VIII Congr. Geogr. Italiano, tenuto in Firenze dal 29 Marzo al 6 Aprile, 1921*, Florence, 1922–23, Vol. 2, pp. 185–194.)

London: A Geographical Synthesis. The geography of a major city is yet to be written. The work is too large for a single hand, because the range of influences that shape a metropolis is too wide to be comprehended by a single mind. The problem of London, however, is being attacked from different sides, all offering material which geography should soon weave into a unified interpretation.

Recent work, dependent on voluminous and scattered sources, has revealed the geography of London in its broad outlines, at any rate up to the Tudor period. Modern London as a whole is too intricate in its subordinated geographic relations

to reveal them yet. The bridgehead occupied by the Romans, where the tidal estuary of the Thames narrowed to negotiable width, is a point which has proved and realized a series of unsuspected advantages that have made every step progressive. In manifold ways the position has suited England, and the world's trade with England, to the subordination of all rival positions. It has moreover proved itself easily adaptable to every increase in the volume of that trade. London, then, is primarily a port. It is also the center of administration and finance, thus executing for England in one place the work done by Rotterdam, The Hague, and Amsterdam for Holland. Sir Joseph G. Broodbank has described the evolution of the port in a truly geographical manner (History of the Port of London, 2 vols., London, 1921). London overcame its most serious disadvantage, the treacherous channels of the estuary, in early times. Between the Conquest and the reign of Henry II the embankments were built by unknown hands for irrelevant purposes. The channel was reduced to one tenth of its width and by tidal scour, unaided, has cleared itself for shipping. From the hithes of the Saxons to the later basins and docks (primarily intended only for the fitting of vessels), through the great dock-building period of the first decade of the nineteenth century when the demands of sailing ships were met, to the subsequent dock extensions for steamers, starting in 1850, the author shows the port in continual growth and says gently that "London is about sixty miles from the sea, i. e. about the distance which an ordinary steamer can cover while the incoming or outgoing tide lasts."

Early London was ruled by its topography. Hilda Ormsby (London on the Thames, London, 1924), has made a big contribution here by providing a contour map of the London region compiled from all available data, no surveyed contour map being in existence. She shows that the size of the *city* of London has been fixed since Roman times by the walls which were erected along the natural line of defense. She gives attention to such important matters as water supply, the evolution of city drainage, the extent of made ground, the evidence of modern drilling, the rivalry of London and Westminster, and the commerce of the city as distinguished from the port traffic.

If early London depended on its topography, the growing town of the Middle Ages was controlled by its geology. This is well shown by C. E. N. Bromehead (The Influence of Its Geography on the Growth of London, *Geogr. Journ.*, Vol. 60, 1922, pp. 125–135). The absorbed villages were mostly placed on water-bearing strata, and the expansion of London took place on the water-bearing Thames gravels overlying the impervious London clay. Potable water was obtainable at a depth of 25 feet, and, until the supply became inadequate and contaminated, it was used exclusively. Here we find London overcoming geographical control. Bromehead and Ormsby both describe the supplementing of the supply by the placing of a waterwheel at London Bridge, then by leading conduits into the city from distant sources. Dr. Morley Davies, in a lecture delivered in London on November 28, 1923, of which we have received a summary, has added further details to this aspect of the geography of London from his own researches on metropolitan hydrology. He also discusses the influence of the river terraces on the growth of the city.

In an historical statement largely concerned with the development of city government William Page (London: Its Origin and Early Development, Boston and New York, 1923) has done great service in providing an account of the administrative boundaries of the city. In late Saxon time the city was divided into "sokes," districts over which private jurisdiction was exercised. These were city fiefs entailing military obligations of defense. From them arose the wards, likewise originally with defensive duties. The parishes seem to have been independent units—a contrast with the rural order of relations. The author suggests also an indication of a critical stage in the peopling of London when he states that "those who in the twelfth cen-

tury wished to find sites for the foundation of new religious houses or for building themselves mansions with grounds, had to seek for land outside the walls" (p. 179). London within the walls was a fully occupied space. Suburbs were growing and were limited by bars on the highroads. Ormsby shows that they grew first on the common lands. Not until the dissolution of the monasteries, when great suburban expansion took place, were they able to spread over ecclesiastical lands.

The aspect of London at various periods may easily be conceived from the illustrations given by Broodbank and Ormsby, but more is available. The city preserves its past and can show actual monuments from which the aspect of past periods can be deduced (G. B. Gordon: Ancient London, [*Univ. of Pennsylvania*] *Museum Journal*, 1922, pp. 177–237 and 257–399).

In comparing the works discussed here, it is not surprising, in view of the vast material involved, to find small discrepancies of scholarship. For example, Page considers that the Saxon street system evolved with little regard to the Roman (pp. 31 and 267), whereas Bromehead states that many Saxon churches faced Roman streets (p. 130). Except for the Saxon period, however, the geography of early London is now comparatively clear. For the much more difficult period since Tudor times a splendid base exists—the Ordnance Survey map in 20 sheets, on a scale of six inches to one mile.

AFRICA

Chronological Records of the Nile Floods and Changes in the Nile Delta in the Middle Ages. Students of climatic cycles will be indebted to Prince Omar Tussun for translations of two medieval Arabic documents throwing light on the history of the floods of the Nile. One of these is a table by Abū'l Mahāsin (1470 A. D.) showing the *maximum* and the *minimum* level of the river (presumably as indicated by the Nilometer at Cairo) for every year of the Hegira from A. H. 20 to A. H. 855 (*i. e.* 640–1451 A. D.). The other is a descriptive chronological table from a work of Ibn Iyās (1524 A. D.) recording all the important floods of the Nile and their consequences from 769 to 1517 A. D.

It is unlikely that there has been any radical and progressive change in the climate of Egypt since a very early period. The bulk of evidence would seem to show that in the time of the Pharaohs and Ptolemies the country was quite as arid as it now is and that the inundations of the river behaved much as they do at the present day (see Hermann Leiter: Die Frage der Klimaänderung während geschichtlicher Zeit in Nordafrika, *Abhandl. K. K. Geogr. Gesell. in Wien*, Vol. 8, 1909, No. 1, pp. 95–100; Leo Berg: Das Problem der Klimaänderung in geschichtlicher Zeit, *Geogr. Abhandl. herausg. von A. Penck*, Vol. 10, No. 2, Leipzig and Berlin, 1914, pp. 62–64). Abū'l Mahāsin's and Ibn Iyās' figures will probably not give any evidence to upset this assertion. On the other hand, if plotted in the form of graphs, these figures should provide a clue to the understanding of periodic oscillations in rainfall in the equatorial regions where the Nile takes its rise. Such graphs would well repay critical comparison with the climatic data furnished by the medieval chronicles of Europe as tabulated by Arnold Norlind (Einige Bemerkungen über das Klima der Historischen Zeit nebst einem Verzeichnis mittelalterlicher Witterungserscheinungen, *Lunds Univ. Årsskrift*, N. S., Section 1, Vol. 10, No. 1, 1914) or with the record of oscillations in climate provided by the study of tree rings (see A. E. Douglass: Climatic Cycles and Tree-Growth, *Carnegie Instn. Publ. No. 289*, Washington, 1919).

The tables of Abū'l Mahāsin and Ibn Iyās are given in a monograph by Prince Omar Tussun entitled "Mémoire sur les anciennes branches du Nil: Époque arabe" (*Mémoires Presentés à l'Inst. d'Egypte*, Vol. 4, Cairo, 1922–1923, pp. 65–213; reference on pp. 135–170. The first part of this "Mémoire" on the ancient epoch

was published in 1922 as Fascicule 1 of the *Mémoires*, etc., Vol. 4, and was noted in the *Geogr. Rev.*, Vol. 13, 1923, pp. 618–619). This monograph as a whole treats of changes in the Nile Delta as recorded by Arabic authors from the ninth to the sixteenth centuries of our era: special chapters are included on the history of the Alexandrian canal and of the canal from Cairo to the Red Sea.

At no time during the entire Arab epoch did the Nile reach the sea through more than three primary outlets. During the first century after Christ there were said to have been no less than twelve outlets, seven of which were of primary importance. In the Middle Ages the Canopic and Pelusiac branches, which in antiquity bounded the Delta on the west and east respectively, had dried up. The only outlets mentioned by all the Arabic authorities quoted by Prince Omar were the Rosetta and Damietta branches. The number of distributaries by which the river reaches the sea and of canals by which its waters are carried through the delta may be regarded as an index of the economic prosperity of the region. Widespread distribution of the life-giving waters is both a cause of greater fertility and a result of the prosperity to which such fertility gives rise. Negligence in the maintenance of the canals during the Middle Ages may be attributed to "political causes and to the continual changes in the government which directed the destinies of the country."

ASIA

Rivers and Settlement in the Indo-Gangetic Plain. "A land of deserted cities" is the essence of Mr. W. H. Arden Wood's paper "Rivers and Man in the Indus-Ganges Alluvial Plain" read before the British Association Meeting, 1923, and published in the January (1924) number of the *Scottish Geographical Magazine*. In northern India the relation between the rivers and human settlement is ancient and intimate. As Vidal de la Blache put it in his analysis of the population distribution of that country, "le rôle de l'eau est donc prépondérant." On the Indo-Gangetic plain one of the most important elements in that relation is the constant change in the river courses—"from year to year and from age to age." The surface of the great flood plain is everywhere seamed with old river channels which are themselves but representative of others obliterated by nature or man. Every such channel signifies a dislocation of human occupation. In the Punjab the lines of mounds marking abandoned villages are so common as to be described by a special term, *theh*. Other causes of course have been operative in the decline of cities and villages of the plain, but none on such a broad and continuous scale. Some ancient cities, such as Benares and Patna, have enjoyed a long continuous existence because of their location on hard clays or the nodular limestone that is an exceptional feature of the fine, easily eroded waste of which the plain is built. For a reconstruction of the physical history of the plain the cities furnish perhaps the most valuable criteria, for they constitute fixed points of reference to which may be applied knowledge from tradition and from the historian and chronicler.

Instances from early and late times are given by Mr. Wood. A special interest attaches to that of the now riverless gap between the Sutlej and the Jumna. The region is the scene of early Aryan occupation and a center whence that culture spread. Climatic change has been invoked as a cause of the approach to desertic or semidesertic conditions, but a sufficient explanation may be found in hydrographic change. Through the region may be followed traces of an old river channel, approximately paralleling the courses of the Sutlej and the Indus to Sind and thence to the Rann of Cutch. It is known as the Hakra. If the Sutlej was its feeder, as certain evidence seems to indicate, the diversion of this notoriously changing stream (the Sanskrit name means "dreadful") to the Punjab system would account for the drying up of the Hakra.

Coming down to the present we find the opinion expressed that "the very existence of Calcutta, not as a port, but as a habitable city, is threatened by the decline of true deltaic conditions in its vicinity." The history of the Ganges delta is in some ways abnormal. The rule that in the northern hemisphere southward-flowing streams tend to advance westward (rotational deflection) is reversed. The Ganges delta from centuries ago has advanced eastward, presumably because of changes of level in the delta, and in the sixteenth century the main Ganges moved eastward to occupy the bed of a smaller stream, the Padma. The western distributary, the Hooghly, which is the sacred branch, has now reached a stage where it is ceasing to function as a live river. Trading settlements above Calcutta flourishing in the sixteenth to eighteenth centuries are extinct as seaports, and though Calcutta is not threatened in this way—so long as the channel is kept clear by the strong tides and scouring action of the freshets of the rainy season—fears are entertained regarding its hygienic state. Calcutta was a very unhealthful city until the present drainage system was established at considerable cost in the latter half of the last century. The drainage is towards a local deltaic channel, the Bidyadhari, which is rapidly silting up.

POLAR REGIONS

The Ross Dependency: A Territorial Addition to New Zealand. With her mandate in Samoa (awarded in 1919) and the recent allocation of the Ross Dependency (August, 1923) New Zealand's territorial jurisdiction is far spread. The procedure by which the Ross Dependency was created (Order in Council) is described in the *Geographical Journal* (November, 1923) and compared with that followed in the case of the Dependencies of the Colony of the Falkland Islands, 1908 and 1917 (Letters Patent).

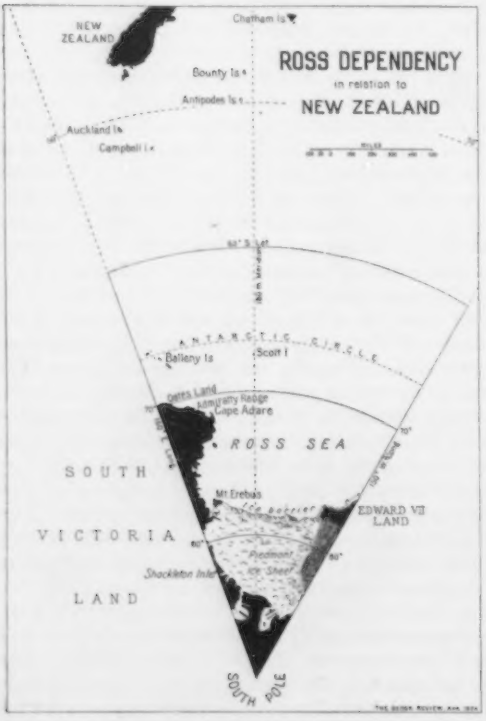


FIG. 1—Map of the Ross Dependency.

The Ross Dependency comprises portions of the Ross and Victoria Quadrants of the Antarctic continent. It is officially defined as "all the islands and territories between the 160th degree of east longitude and the 150th degree of west longitude, situated south of the 60th degree of south latitude." The sector includes Edward VII Land, discovered by Scott; the great ice barrier now known as the Ross Piedmont; the Ross Sea; and the façade of South Victoria Land. The coast has been fairly well charted, but two comparatively large areas remain unexplored—the Admiralty Range with its hinterland as

far as Oates Land and King Edward VII Land with its hinterland (H. T. Ferrar: History of Ross Dependency, *New Zealand Journ. of Sci. and Technol.*, Vol. 6, 1923, pp. 205–208). Possession was first taken by Ross in 1841, and the area is known through the successive explorations of the last quarter-century—especially Scott's first and second expeditions and Shackleton's first expedition.

The New Zealand government receives the dependency free of cost. It will issue licenses for whale and seal fishing in the seas of the new dependency.

HUMAN GEOGRAPHY

Overpopulation: The Limitations of an Idea. The word "overpopulation" is in current public use. It expresses conditions of discomfort in certain communities, connected in the public mind with a belief that the number of inhabitants has become excessive. Its loose and vague use has almost stripped the term of scientific value. So intricate are the connections between social conditions and numbers, that it is difficult to state when and why numbers are excessive. Nevertheless, the public mind has discerned a possible or real social condition. It is the duty of social science to investigate and define it.

An attempt has already been made in these pages to give definite meaning to the term (*Geogr. Rev.*, Vol. 13, 1923, p. 282). Mr. J. Lionel Tayler removes an element of confusion in pointing out that "overpopulation" is distinct from "overcrowding." The latter condition is easily definable in scientific terms. He suggests that those who speak of overpopulation mean "that human beings are *in the mass* at the limit of their powers [to make use of available resources], and there is no reasonable prospect of an improvement of them for a century or two; hence an increase in population, as the present methods of industry would not be greatly improved, would be dangerous" (J. L. Tayler: Overpopulation, *Sociological Rev.*, Vol. 15, 1923, pp. 235–236). Sir William H. Beveridge indicates a further limitation. He shows that in England from the evidence of past experience, especially that of 1879 and 1886, the ratio of unemployment is not an index of overpopulation (W. H. Beveridge: Population and Unemployment, *Nature*, No. 2815, Vol. 112, 1923, Oct. 13, pp. 548–550; *idem:* Population and Unemployment. *Econ. Journ.*, Vol. 33, 1923, pp. 447–475). He goes further, in criticism of J. Maynard Keynes, and shows that in Europe, in the period 1880–1920, the yield and per capita production of food crops and certain raw products increased steadily with increase of population. This means little without an examination of the all-important rates of increase, which he does not make. He also shows that the real cost of corn fell during the period, in England, and that steady progress was made in material production. His conclusion is that the British outlook need not be clouded but that the population problem, owing to inevitable great increase, remains for the future. Keynes makes effective reply (J. M. Keynes: A Reply to Sir William Beveridge, *Econ. Journ.*, Vol. 33, 1923, pp. 476–486). He produces statistics that relate better to the problem than those used by Beveridge and shows that the British relation of the volume of manufactured export given for a uniform quantity of food import improved steadily to about 1903, after which it deteriorated. The manufactured exports of Great Britain "are now buying *in the aggregate* about 12 per cent less foodstuffs than before the war." This suggests that a higher standard of life could be maintained if there were fewer to employ and to feed. If this be true, numbers are already inimical to standards of life in Great Britain.

From Germany comes a very earnest and detached study of the matter, surprising indeed when one recalls the German policy of fecundity (Ottokar Landwehr: *Übervölkertes Land:* Eine bevölkerungspolitische Studie über Gegenwart und Zukunft Europas, Vienna and Leipzig, 1923, 59 pp.). It says little that is not available in English, being indeed a general statement of the population problem

in terms familiar to American students; but its tone and source give it importance. Landwehr assumes that France exhibits the desirable condition. He regards 100 persons a square kilometer as the average limit of occupation. With this standard of reference, he has compiled a table showing the overpopulation and underpopulation of the countries of Europe. He regards Europe, except Spain, Russia, and the Balkan regions, as overpopulated, Germany and England excessively so. His remedy is a more even distribution, starting at home, to be followed by emigration, with Russia as the receptacle for German overflow.

Switzerland is the classical example of an "open" population—one dependent on the import of fundamental necessities and getting them by the export of manufactured "equivalents". Julius Weyler interprets the present condition of the Swiss in the light of the past (Das Ubervölkerungsproblem der Schweiz, Separate from *Zeitschr. für Schweizerische Statistik und Volkswirtschaft*, Vol. 59, 1923, pp. 3–39). People engaged in the manufacture of equivalents form an "excess" population. We may speak of overpopulation only when the equilibrium between the capacity and the size of a population must be restored by restriction of its growth or modification of its constitution. Those processes directed towards diminution express overpopulation only when their connection with an economic basis insufficient for existing needs is demonstrable. Weyler's argument is involved but shows well enough that the trend of Switzerland from the Middle Ages has been from decreasing overpopulation to increasing excess population. The Swiss have found it profitable to develop their rural effort into high-grade dairy production and that of their handicraft into refined manufacture, like ribbon weaving, embroidery, and the making of instruments. They sell their goods to buy their food. The country thus reacts sensitively to changes in the outside world. The war on the whole proved favorable, many products being in high demand, but the peace has brought a reduction of the purchasing power of customers. Hence a period of overpopulation is pending. The economic basis of food will be insufficient. The consequences of war in Europe have had the same effect in the past. The condition will be met by increased death rate, decreased marriage and birth rates, and by emigration—the reduction of unnecessary numbers by all suitable means.

The war left Vienna and Petrograd overpopulated. They have lost since the war 0.46 and 1.26 million people respectively (Landwehr). The national economic needs that rendered necessary the presence of the former numbers at both places have diminished greatly. The past numbers are no longer required there and in consequence cannot be maintained. No place which requires the presence of large numbers in order that the life of a population group may proceed normally is overpopulated as long as a mechanism for feeding them can be maintained. Whatever be the conditions of overcrowding or unemployment of part of the community, equilibrium of population will exist as long as economic processes call and keep the numbers there at the average standard of life of the group. Standards must be maintained. "Recoil from standards once reached is the gesture of a community touched by decay" (Beveridge).

Recent Studies in the Geography of Coal Resources. The question of the exhaustion of the world's oil resources is one of immediate economic importance: on the other hand the date of the ultimate exhaustion of the coal reserves is, at the present time at least, more or less an academic question. Though the figures quoted vary widely, in any case there probably is sufficient coal to last several centuries even in those countries that are less well endowed. More serious and immediate problems are presented by the geographical circumstances of the various coal fields—their positions in relation to markets and to political frontiers—and, in the economic field, by the control of output and distribution. Some of the

more important of these problems are clearly explained by Dr. Walter S. Tower in an article entitled "The Coal Question" (*Foreign Affairs*, Vol. 2, 1923, pp. 100–116) and in a booklet by Professor A. J. Sargent, "Coal in International Trade" (London, 1922).

The three greatest coal reserves in the world are to be found in China, western Europe, and eastern North America. The Chinese reserves at the present time are virtually nonproductive and far removed from the industrial centers of modern civilization. The coals of western Europe lie in two primary areas each productive of a surplus of supply: Germany and Great Britain. Prior to the World War these two areas between them were able to supply the demands of the remaining "deficit" areas of Europe, and British coal was also furnished to South America without meeting competition. The dislocation of the economic structure of Europe as a result of the war and the tremendously enhanced costs of production have thrown out of adjustment the delicately balanced international coal trade. During 1920 and 1921 American coal was actually sold in Europe itself at lower prices than British coal, and this despite the serious geographical disadvantages under which America labored. The cost of producing a unit quantity of coal in America is so much less than in England, that the expense of carriage from the mines of Pennsylvania and West Virginia to the sea at Hampton Roads and thence to Europe failed to raise the price of American coal to the British level. Though American competition has not been maintained in Europe since 1921, its revival is an ever-present possibility, a possibility that can only be met by rigid economies in all phases of British production.

About half of the total coal reserves of the world exists in the form of coals of low grade, brown coals and lignites, containing large percentages of water and low percentages of carbon. In order that these may be made serviceable for industrial purposes they have to undergo the somewhat elaborate process of drying and conversion into briquettes. Before the World War brown coals were mined and briquettes were manufactured on a large scale in Germany and Austria, and now Germany is reported to be producing nitrogen products from lignites on a commercial basis. Their use was little known in the United States and the British Empire, but as the cost of extracting bituminous and anthracite coal increases the time will inevitably come when the Anglo-Saxon nations will have to turn to these inferior grades. They are present in abundance in the United States, about one-third of the total estimated coal resources of this country consisting of lignites in Texas, Alabama, the Dakotas, Montana, and Wyoming (see W. A. Bone: Brown Coals and Lignites, *Journ. Royal Soc. of Arts*, Vol. 71, 1923, pp. 172–184, 189–199, and 208–216; *U. S. Bur. of Mines Technical Paper 178*).

While the "Coal Resources of the World," the well-known work based upon investigations made on the initiative of the executive committee of the Twelfth International Geological Congress which met in Canada in 1913, remains the fundamental quantitative study of the coal resources of the world, its reports must be used with caution. Exploration of coal reserves has made notable progress since they were published. Furthermore, the data included in the reports themselves and the manner in which these data are presented have not escaped criticism. It has been pointed out that the classification of coals according to their chemical analyses is of little significance from the practical and industrial points of view and that a better classification might have been made if geological ages had been used as the criteria. More serious has been the charge that the various contributors failed to maintain uniform standards in estimating reserves, thereby rendering the statistics of doubtful validity when employed for purposes of comparison. The reports of most countries draw a distinction between "actual" reserves, "including cases in which the calculation of the amount is based on a knowledge of the actual thickness and extent of the seams," and "probable" reserves, "including

cases in which an approximate estimate only can be arrived at." This important distinction was not made in the report of the United States, the country with the greatest reserves.

These and other observations regarding the "Coal Resources" are expressed by Dr. F. Frech in a volume entitled "Die Kohlenvorräte der Welt" (*Finanz- und Volkswirtschaftliche Zeitfragen No. 43*, Stuttgart, 1917). Dr. Frech discusses the world's coal reserves country by country. In want of other sources upon which to draw, much of his material was taken from the reports of the Canadian congress, though these reports were throughout subjected to severe criticism. For Germany he adds new information based on personal observation and on data published later than 1913. Writing during the stress of the World War, Dr. Frech had political and nationalistic aims in view, among them ultimate and permanent control of the Belgian fields by Germany. The book appears to exaggerate the potentialities of coal production in Germany while minimizing the reliability of British and American figures. On the whole, however, its value as a work of reference and as a corrective of "Coal Resources" is not vitiated by its nationalistic bias.

In regard to the British Empire the data supplied in "Coal Resources" may also be supplemented by J. H. Ronaldson's monograph, "Coal" (*Imperial Institute Monographs on Mineral Resources with Special Reference to the British Empire*, London, 1920). This contains detailed descriptions of the various coal fields of the empire in their geographical and geological positions. For the United States we know of no more recent general discussion than that contained in "The Coal Resources of the World." The history of the production of coal with full statistics is thoroughly covered in the serial publications of the U. S. Geological Survey. The latest number of this series is "Coal in 1919, 1920 and 1921," by F. G. Tryon and Sydney A. Hale (*Mineral Resources of the United States*, 1921, Part II, pp. 445–662, Washington, 1923).

Reference may also be made here to an admirable manual by Elwood S. Moore, "Coal: Its Properties, Analysis, Classification, Geology, Extraction, Uses and Distribution," New York, 1922. As the title implies, a large part of the volume is devoted to geological and technological matters of indirect geographical interest. On the other hand, as the utilization of various kinds of coal for different purposes and in different regions may be of much geographical significance, the student will find Professor Moore's chapter on classification useful for reference.

HISTORY OF GEOGRAPHY AND EXPLORATION

The Earliest Known Printed Map Showing America. The Contarini map, recently acquired by the British Museum and widely mentioned in the press, is of special interest because, so far as is known, it is the "very first printed map in which the discoveries in America are represented" (Mr. Edward Heawood discusses it in the *Geogr. Journ.*, Vol. 62, 1923, pp. 279–293). Previously this honor had been claimed for the famous Waldseemüller map discovered by Josef Fischer in 1901, and, prior to that, for the map of Johan Ruysch in the Rome Ptolemy of 1508. Important manuscript maps showing the American discoveries had been made, however, before 1506, notably that of Juan de la Cosa, who took part in the first expedition of Columbus, and the Canerio and Cantino maps.

The Contarini map is on a fan-shaped conical projection similar to that of the Ruysch map. As on other maps of the period, the northeast coast of Asia is made to extend eastward to a position not far west of northern Europe. The northern coast of South America is shown as a border to a great continent extending indefinitely toward the Antarctic regions. In the midst of a broad belt of ocean con-

necting the Atlantic and Pacific between South America and Asia lie Cuba, Hispaniola, and the other West Indies. No land is represented immediately west of the West Indies as on the maps of Juan de la Cosa, Cantino, Canerio, Waldseemüller, and Ruysch. Mr. Heawood points out that this omission tends to confirm the scepticism of those who doubt the authenticity of "Vespucci's discoveries in the extensive voyage which he claimed to have made on the coasts of North America in 1497–8." The belief that Columbus had reached the coast of Asia is indicated by a legend off the southeast coast of that continent.

Asia, as depicted on the Contarini map, is for the most part the Asia of the Ptolemaic atlases, the details of which came in part from Ptolemy and in part from Marco Polo, though it is probable that "*map*-sources not known to us must have been drawn upon too." Portuguese discoveries in the Indian Ocean are represented by the curious addition of a peninsular India to the west of the Ptolemaic India which is retained. Similar duplications resulting from the use of different sources of information in regard to one and the same region are not infrequent in other maps of the time. The general outline of Africa is good. The sources of the Nile are shown far to the south in the usual manner of the Ptolemaic atlases. The Blue Nile, the course of which had been drawn with accuracy in the map of Fra Mauro (1457–1459), is made by Contarini into a great *western* branch of Ptolemy's system of the Nile. In the outlines of Europe Contarini made many improvements over the maps of Ptolemy based on the examination of the more accurate marine charts of the day. To mention a single example, he eliminated the exaggerated eastward extension of Scotland.

The Geography of Dante. The writings of Dante Alighieri not only express the current geographical ideas of his age but also reveal much originality in the treatment of certain geographical problems. The poet's sources of information were primarily those great encyclopedic compilations that were so popular in the Middle Ages, though for local detail he drew upon his own memory of places visited and upon the reports of contemporaries. The influence of Arabic science had been a potent force in Western Europe since the eleventh century. Dante was largely indebted for his astronomy and astronomical geography to Al Farghānī (known in the Middle Ages as Alfraganus) whose "Elements of Astronomy"—itself based upon the "Almagest," or famous astronomical treatise of Ptolemy—was available in Latin translation.

Dante writes of geographical matters in the "Convito," in the "De vulgari eloquentia," and in numerous scattered passages throughout the "Divine Comedy." A general discussion of the poet's geography and its origins will be found in Edward Moore's "Studies in Dante: Third Series," Oxford, 1903, pp. 109–143 (abstracted and reviewed extensively by Giuseppe Boffito and E. Sanesi, "La geografia di Dante secondo Edoardo Moore," *Riv. Geogr. Italiana*, Vol. 12, 1905, pp. 92–101 and 204–215). Recently, Italian scholars have been investigating the poet's treatment of various important topics not touched upon by Moore. The results of these investigations are embodied in three publications: "La geografia nell'opera di Dante," by Assunto Mori (*Atti VIII Congr. Geogr. Italiano*, Vol. 1, Florence, 1822, pp. 271–299); "La carta dialettologica d'Italia secondo Dante, by Giuseppe Andriani (*ibid.*, Vol. 2, pp. 255–263); and "L'Italia nella Divina Commedia," by Paolo Revelli, Milan, 1923.

Dante believed that the earth is a sphere immovably fixed in the center of the universe and that it is 20,400 Italian miles in circumference. He held that the "emergent earth," or dry land, was restricted to an area not more than 180 degrees of longitude in length by about 67 degrees of latitude in width. The remainder of the sphere was covered with water. Of the three continents he probably thought

that Asia was equal in size to Europe and Africa put together and that the Mediterranean Sea was 90 degrees of longitude in length, or half the total length of the inhabitable world. Jerusalem he placed at the center of the lands and at the antipodes of Jerusalem the mountain of Purgatory with the Terrestrial Paradise upon its summit. He explained in some detail the correlation between differences in longitude and differences in local solar time and the division of the earth's surface into seven *climata* or zones the borders of which were determined by the length of the longest day.

With the exception of the theory placing the Terrestrial Paradise in the southern hemisphere—it was usually believed to be in Asia by medieval scholars—none of these views was altogether original. Dante's treatment of the larger problems of geography was for the most part in accord with the orthodox traditions of his age: though his assumption that the southern hemisphere is covered by water was based upon Arabic and classical, rather than upon patristic or subsequent European teachings. The theory, however, was a familiar one in the thirteenth century and was sometimes explained by the hypothesis that the spheres of earth and water, instead of being exactly concentric, have different centers. An interesting argument against this hypothesis is given in a treatise entitled "Quaestio de aqua et terra" often attributed to Dante but of doubtful authenticity. Here the presence of land in the northern hemisphere alone is ascribed to the power of the stars which "attract the land as a magnet attracts iron."

Though Dante wrote no treatise devoted specifically to geography, he had a clear understanding of the relative positions of places in Italy and its neighboring lands. The descriptions of regions in the "Divine Comedy" are brief but extremely incisive and accurate. In framing them it is possible that the poet may have had maps before him, and there are certain passages in the "De vulgari eloquentia" that could hardly have been written without reference to a map.

GEOGRAPHICAL NEWS

The Reports of the Eighth Italian Geographical Congress. The work of the Eighth Italian Geographical Congress, held at Florence, March 29 to April 6, 1921, is described in three large and handsome volumes ("Atti dell' VIII Congresso Geografico Italiano tenuto in Firenze dal 29 Marzo al 6 Aprile 1921," Istituto di Edizioni Artistiche, Fratelli Alinari, Florence, 1922–1923). On looking over the books one can hardly fail to be impressed by the ambitious scope of the geographical work being done in Italy and by its high scholarly standard.

The Italian geographical congresses have been held from time to time since 1892. The seventh met at Palermo in 1910. A long interval, therefore, preceded the eighth congress and explains in some measure the magnitude of the work undertaken by it. The eighth congress was divided into five sections designated severally "scientific," "historical," "educational" (*didattica*), "economic," and "colonial." Volume I of the "Atti" contains the texts of the three lectures delivered before the whole congress; together with the record of the proceedings, plans discussed, and votes taken. Volume II is devoted to the publication of the papers (*comunicazioni*) delivered before the sections. Volume III includes a guidebook and chronicle of the excursions and catalogues of the exhibits.

Of the ninety-four papers read at the section meetings, thirty-six were devoted to scientific and twenty to historical geography; eleven to educational problems; six to economic and eighteen to colonial matters. To judge from the topics under discussion and the papers presented interest was overwhelmingly centered in the geography of Italy and her colonies. Except for communications on the thalassography of the Mediterranean, on the distribution of paleolithic industries in Europe,

on the Himalaya (based upon the expeditions of De Filippi in 1913–1914 and of Mario Piacenza in 1913), and a lecture by Father Alberto de Agostini on his journey to Tierra del Fuego in 1913, the attention of the congress was focused exclusively on matters of local and national concern.

Of the papers read before the scientific section, the majority were reports of detailed investigations in physical geography. To the subject of present and former glaciation in the Alps and Apennines were devoted no less than six communications accompanied by photographs and maps of peculiar glacial forms. An unusually interesting contribution by Professor A. Malladra on the crater of Vesuvius is discussed in the present number of the *Geographical Review* (p. 308). Among other contributions on local problems but of more than local importance may be mentioned Professor Carlo de Stefani's treatment of the geological and physiographic relations between the opposite sides of the Adriatic; in the field of thalassography a study of the currents of the western Mediterranean (see this number of the *Review*, p. 310) by Professors V. Baldasseroni and G. Stefanini; a study of the anthropogeography of Mt. Argentario on the Tuscan coast by Professor Assunto Mori; and, in phytogeography, a discussion of colonies of Mediterranean plants near Lago di Gardo by Professor A. Beguinot.

The long and rich historical background of their country and the intimate connection between geography and history in the curriculum have led Italian students assiduously to cultivate the fields of historical geography and the history of geography. One of the three lectures published in the "Atti" is a discussion by Assunto Mori of the geographical conceptions of the time of Dante (see this number of the *Review*, p. 319). Most of the contributions read before the historical section were on topics connected with the geographical and cartographic work of various Italian scholars and writers of classical, medieval, and early modern times.

Seven of the eleven papers read before the educational section were on the geographical work being done by Italian publishing houses. The economic section listened to communications on special agricultural and industrial problems in various parts of the Italian peninsula. The colonial section occupied itself primarily with the political and economic geography of the Italian colonies and of Anatolia.

Excursions were an important feature of the congress. The illustrated guide to the principal excursion through central Tuscany and the Maremma should admirably serve future students and travelers as a treatise on the physical, historical, and human geography of these regions.

The catalogues of the exhibits are of value from the bibliographical and cartobibliographical points of view. They include an extensive descriptive list of maps, geographical manuscripts, and printed books of the Reale Archivio di Stato of Florence, a catalogue of geographical maps of Italy dating from the fourteenth to the end of the eighteenth centuries, a list of the most important official maps of the present day, and a catalogue of geographical materials (books, models, maps, globes, etc.) exhibited by various Italian publishing concerns for use in schools.

The Geographical Institute of Petrograd. This Institute, established in the autumn of 1918, is the outcome of a long-continued effort to make advanced geographical study and research in Russia contribute to the preparation of teachers and government experts. It is an outgrowth of the Geographical Bureau, started in 1910, and of the Advanced Geographical Courses, organized in 1913 under the Ministry of Agriculture. Although space does not permit the mention of names, it may be noted that several members of these earlier undertakings are included in the personnel of the new organization.

The Institute stood, by 1922, as an independent member of the group of establishments for higher learning maintained by the Commissariat of Education.

There were then two faculties: General Geographical and Ethnographical. Besides the regular four-year course for specialists, the Institute maintained a preparatory course and a programme of public courses for the popularization of geographical knowledge. Despite material difficulties, classrooms and laboratory facilities had been obtained, field excursions organized, and a library of some 20,000 volumes assembled. The student body had risen to over 800. Student activities, through a general Geographical Club and special societies, formed an important supplement to the regular work.

The aim of the Institute is to provide, through its own curriculum and faculty, a complete education in geography and allied branches of knowledge. Owing, doubtless, to former connections, the early programmes displayed a strong bent toward the exact sciences and agriculture, at the expense of social studies; but, since the transfer to the department of education, there has been an increasing recognition of the relation of geography to politics, economics, and history. This tendency is particularly evident in the public lectures and incidental activities of the Institute.

As part of its educational work, and as contributions to the advancement of geographical knowledge, the Institute conducts expeditions transcending the character of routine field work. In 1920 such expeditions were carried out to the Kola Peninsula and to the Tver government and, in 1921, to the Caspian.

The Institute has had in view a policy of publication of the results of its expeditions and other work, of special studies, of textbooks, and of popular pamphlets. It has undertaken the preparation of a comprehensive atlas of the Petrograd government on a scale of 1: 600,000 and has been charged by the commission of the Supreme Economic Council with the study of the natural resources of Russia and with the compilation of the local volume of a new set of regional studies.

The Institute's own work of publication has been hampered by printing difficulties. It has contrived to get out its annual *Izvestia*, containing special articles and statements as to its work. In 1921 it began publication of a magazine, first called the *Bulletin* and, in 1922, changed to *Geograficheski Viestnik*, made up of articles, reviews, and news notes. Three small volumes of reports on the soil and vegetation of the Kola Peninsula, results of the expedition of 1920, have come to the American Geographical Society (see the note on the Kola Peninsula in this number of the *Review*, p. 307); likewise, a 300-page work on evolution, by Professor L. S. Berg, as the first volume of a series of monographs. A little pamphlet on the practical problems and political significance of geography is a sample of the work of popularization.

J. V. FULLER

A Course of Lectures on Polar Exploration. Mr. R. E. Priestley is giving a course of lectures on "The History and Science of Polar Exploration" at Cambridge University. The detailed syllabus is in itself an interesting and useful outline. Some idea of the scope is afforded by the titles to lectures, which read as follows: I, A Modern Scientific Polar Expedition; Scott's Last Expedition (*Terra Nova*, 1910–1913); II, The Geography and Early History of the Polar Regions; III, The Elizabethan Period of Arctic Exploration. Arctic Work and Methods to the Close of the Eighteenth Century; IV, Parry and Franklin; V, The North-West Passage: Nineteenth Century Arctic Exploration; VI, The Quest of the North Pole. The Peary-Cook Controversy; VII, [The Scientific Polar Expedition]; VIII, Early Antarctic Exploration; IX, The Attainment of the South Pole; X, Shackleton; XI, The Psychology of Polar Exploration; XII, Polar Ice; XIII, Polar Life; XIV, Man and the Polar Regions; XV and XVI, Polar Economics.

Obituary

Mr. Philip Lee Phillips, Chief of the Division of Maps of the Library of Congress since 1897, died in Washington, D. C., on January 4, 1924. Mr. Phillips' work dealt mainly with the bibliography of cartography. His principal work is "A List of Geographical Atlases in the Library of Congress, With Bibliographical Notes" (4 vols., Library of Congress, Washington, D. C., 1909–1920). This work includes 5324 titles; it is especially useful in its analysis of the various editions of Ortelius, Mercator, Blaeu, and other atlases of the same period. In 1901 had appeared a similar "List of Maps of America in the Library of Congress." A constituent part of this work, "A List of Works Relating to Cartography," appeared separately in the same year. At the time of his death Mr. Phillips left in unpublished manuscript form a descriptive list of books and magazine articles relating to maps, mapmakers, and views which, if printed, would make approximately five volumes of 1000 pages each. Mr. Phillips also compiled lists of maps on Alaska, Cuba, and the Philippines (the two last accompanying bibliographies of these islands) and annotated catalogues on European topographic map series and maps dealing with the World War. He also edited reprints of various rare American maps such as Filson's map of Kentucky, Herrman's map of Virginia and Maryland, Fitch's map of the Old Northwest, and Cutler's map of Ohio. Mr. Phillips' numerous works, although in some matters reflecting the antiquarian point of view (such as giving prominence to the size of maps to the exclusion of their scales when these do not appear on the maps themselves), are indispensable tools, especially to the student of the historical geography of North America.

GEOGRAPHICAL REVIEWS

The Mt. Everest Expedition of 1922

C. G. Bruce and Others. **The Assault on Mount Everest, 1922.** xi and 339 pp.; maps, ills., index. Longmans, Green & Co., New York; Edward Arnold & Co., London, 1923. $7.50. 10 x 7 inches.

Since the appearance of a note in the *Geographical Review* for October, 1923 (Vol. 13, pp. 620–623), outlining the work of the Mt. Everest expeditions of 1921 and 1922 the book under review has been published. Like its predecessor devoted to the explorations of 1921 ("Mount Everest: The Reconnaissance, 1921," Edward Arnold & Co., London, 1922) the present volume is made up of contributions by various members of the party. General Bruce, the commander, gives a broad narrative of events. The first attempt to reach the summit (29,141 feet), by which an altitude of 26,985 feet was gained, is described by Mr. G. H. Leigh-Mallory. The attempt with oxygen, during which the climbers got within half a mile of the top and to an altitude of 27,235 feet, is narrated by Captain George Finch. The story of the disastrous third attempt, ending in the overwhelming of the climbing party by an avalanche below the North Col and in the death of seven porters, is told by Mr. Mallory. Notes on acclimatization at high altitudes, on color in Tibet, and on Tibetan culture are contributed by Mr. T. H. Somervell; and a note on natural history (plant and animal life) by Dr. T. G. Longstaff.

All other considerations were subordinated to the main purpose of the expedition: the attainment if possible of the summit of Mt. Everest. Consequently, though the work done was of great significance from the mountaineering point of view, less was accomplished geographically than in 1921. But, though little in the way of precise scientific observation is reflected in the record of the expedition, the volume is of importance to the geographical reader for the picture it presents of the barren landscapes of southern Tibet and of the stupendous scenery of the world's highest mountain. The incidental notes on Tibetan life and customs are also illuminating if not extensive.

In addition, the volume is full of valuable observations on the reactions of body and mind to high altitudes. The ability of the body rapidly to become acclimatized to elevations of over 20,000 feet was demonstrated. Prior to the expedition the view was widely held that such acclimatization was impossible. Experience showed, however, that physical exertions which seemed almost unbearably difficult upon first arrival at great heights became relatively easy after the explorers had remained several days at the upper camps. Mr. Somervell, indeed, does not see a theoretical limit to acclimatization "at any elevation below the top of Mt. Everest." In other words, there is vastly less difference in atmospheric pressure and oxygen content between 23,000 and 29,000 feet than there is between any two points differing in elevation by 6000 feet below the level of 23,000 feet. The body once adjusted to conditions at 23,000 feet does not have to undergo any further radical adjustments in the ascent to 29,000 feet. Provided, therefore, that weather conditions be favorable and camps be established at sufficiently great altitudes, it seems probable that the summit may be reached by a future expedition even without the aid of oxygen transported for the purpose.

The benefits of the use of transported oxygen, however, were established without question. With the aid of oxygen the second party managed to climb from 25,500 to 26,500 feet at a rate of about 900 feet an hour: the first party, consisting of men fully

as experienced and fully as fit physically and under weather conditions more favorable, if anything, could do no better than 330 feet an hour at corresponding altitudes.

The psychological effects of fatigue, prolonged exposure to cold and wind, and above all of insufficient oxygen are fully as marked as the physical effects. At great altitudes all the forces of environment combine not only against the body but against the mind and will as well. Messrs. Mallory, Finch, and Somervell, well aware of the importance of observing these psychological effects, illustrate them by many personal details of a sort that would seem trivial if told in connection with an expedition made under ordinary conditions. In connection with an expedition made into such an exceptional environment, detailed incidents and personal impressions assume a high degree of interest and value. These are given in the present case with simplicity, informality, and straightforwardness.

Gaspé Peninsula

J. M. Clarke. **L'Île Percée: The Finial of the St. Lawrence, or Gaspé Flaneries, Being a Blend of Reveries and Realities; of History and Science; of Description and Narrative; as also a Signpost to the Traveler.** xii and 203 pp.; maps, ills., bibliogr. Yale University Press, New Haven, 1923. $3.00. 9 x 6 inches.

Dr. Clarke has elsewhere written at length about this interesting part of the province of Quebec. His scientific reports have described in detail the geology and paleontology of the eastern coast of the peninsula, and his "Heart of Gaspé" has given us many interesting notes about its history and geography. In the present volume he has woven into a completed picture a long series of interesting facts about the country and its people and has succeeded in putting into words the charm which impresses all its visitors. There is no pen which could better be entrusted with such a task.

Percé is situated at the eastern end of Gaspé. In "L'Île Percée" we are not hurried at once to this most striking and interesting point on the whole coast; we approach it gradually, first by a route along the south shore of the peninsula and then by way of the St. Lawrence River. Along the former route we stop here and there to pick up bits of local color, to hear some interesting anecdote about places and people, or to listen to some personal reminiscences or bits of local history. It is now the habitant or the fisherman, now the Indian, now a bit of geology such as the Devonian fishes of Scaumenac Bay or modern fishing stories of a different variety taken from the Restigouche and Cascapedia streams which are used to entertain us. We pass on down the Bay of Chaleur past Percé to Gaspé Basin, the place where Cartier landed in 1534 and erected his cross with the arms of France and the scene of other interesting historic events.

An alternative pathway to Percé is by way of the St. Lawrence. This is a more difficult route, for this time we can travel only a part of the distance by train or motor car; but one who follows this route will find it fully as interesting as the one more commonly used along the Bay of Chaleur; one regrets that in "L'Île Percée" we are hurried along this northern route with only a few pages devoted to this whole stretch of coast.

The last part of the book is devoted to Percé and its vicinity. We are given historical sketches and a description of modern scenes; we are told something of the geology of the region and of its geological history; we are taken to Bonaventure Island and introduced to the sea fowl that inhabit its cliffs.

To the traveler who visits Gaspé the book has an especial appeal; to those who have not had that good fortune it serves to give a series of impressions that could not be obtained from any general geographic descriptions.

F. J. Alcock

Exploration and Control of the Colorado River

Lewis R. Freeman. **The Colorado River: Yesterday, To-day and To-morrow.** xix and 451 pp.; maps, diagr., ills. Dodd, Mead & Co., New York, 1923. 9½ x 6½ inches.

The assonantal titles of the two main parts of this volume suggest the topics with which it deals: "Finding the River" and "Binding the River." Mr. Freeman is a skillful riverman—"river rat," as he calls himself—and talented writer of books of travel. Here he turns to history—the chronicle of the exploration of the canyons of the Colorado—and to a discussion of the thorny problems of the control and utilization of that river's unruly waters. He writes in a simple, straightforward, and often colloquial manner. His restraint in the use of adjectives depicting the colors of the canyons is admirable, and the weakness of others in this respect—illustrated by citations and neat comments—provides him and his readers with no little amusement. The volume is too important a work to lack—as it does—an index and it would also have been helped by more detailed maps.

Before the appearance of Mr. Freeman's book the best history of the exploration of the Colorado River was F. S. Dellenbaugh's "The Romance of the Colorado River" (G. P. Putnam's Sons, New York and London, 1906). Writing seventeen years later, Mr. Freeman has brought the story up to date by recording the notable events of the years between 1906 and 1922. The final episode in the long record of exploration and adventure, which goes back to the days of the *conquistadores* of the sixteenth century, is not treated. This episode was the U. S. Geological Survey's expedition of 1923, of which Mr. Freeman was himself a member, and whose work is narrated in the present number of the *Geographical Review* (pp. 177–196).

Mr. Freeman has made use of documentary material not known to Mr. Dellenbaugh in 1906 relating to earlier voyages. Hence, the volume sheds new light, among other matters, on General Ashley's trip down the Green River canyons in 1825 ("the first boat voyage down any of the canyons of the Colorado"), on the old controversy over the wholly unfounded claim that James White had passed through the Grand Canyon in 1867, two years before Powell's first expedition, and on the voyages of R. B. Stanton and F. M. Brown in 1889.

The problems of "binding the river" are problems of irrigation, hydro-electric development, and flood control. It is towards solution of these that the recent U. S. Geological Survey work in the canyons has been directed.

A Physical Geography of Argentina

Franz Kühn. **Fundamentos de fisiografía argentina.** ix and 217 pp.; maps, ills., bibliogr., indexes. *Biblioteca del Oficial, Edición Especial*, Vol. 49–50, September-October, 1922. P. Preusche, Buenos Aires. 10 x 7 inches.

If there were available a first-class map of Argentina one would find upon it most of the material in this book. In addition the book contains photographs, a useful if not complete bibliography, and a number of statistical tables and maps. Dr. Kühn is to be commended for the convenient arrangement of a mass of material distinctly valuable in the study of the geography of Argentina and hitherto scattered in hundreds of references in several languages. There is a brave introduction by Professor Hicken, of the Military College at Buenos Aires, and in it one will find a mixture of many kinds of knowledge and comment thereon, but little on the subject of physiography. In spite of the "modern" views expressed in Professor Hicken's introduction the mode of treatment of the material can only be called antiquated. If geography is straight description, then this may be justly called a physiography,

for there is practically no explanation except in geological terms. It is interesting to know that in 1914 Argentina had a population of 7,905,502, or 2.7 per square kilometer, that Patagonia has a population of 0.13 per square kilometer, and that one-fifth of the whole population lives in Buenos Aires; but these are facts and nothing more. To become science they must be put into some sort of relationship with other elements, and if possible causal ones. There is a map showing the regional divisions of Argentina, and a series of maps dealing with the climatic elements, that is temperature, rainfall, and the like. Data respecting the climatic elements are then employed to subdivide the country into climatic regions and subregions. It is here that science appears. The author's specialty is botany, and we have a substantial ending to the book in Chapter 7, which deals with the ecology or phytogeography of Argentina. Ten phytogeographic regions are recognized. Physiographic and climatic conditions are made to bear upon an explanation of the distribution of plant life. Accompanying the volume are certain special maps in sheets. The Viedma Glacier is shown in a colored contour map, scale 1:300,000. The waterways in the neighborhood of the town of Paraná are represented in detail, and likewise the swamps and drainage ways of the Lake Iberá region in the Mesopotamian country of the northeast.

Volcanism in Alaska

C. N. Fenner. **The Origin and Mode of Emplacement of the Great Tuff Deposit of the Valley of Ten Thousand Smokes.** 74 pp.; maps, diagrs., ills. *Natl. Geogr. Soc. Contributed Technical Papers, Katmai Ser. No. 1 (Papers from the Geophysical Laboratory, Carnegie Instn. of Washington No. 480)*, 1923. 10 x 6½ inches.

E. T. Allen and E. G. Zies. **A Chemical Study of the Fumaroles of the Katmai Region.** pp. 75–155; maps, ills. *Natl. Geogr. Soc. Contributed Technical Papers, Katmai Ser. No. 2 (Papers from the Geophysical Laboratory, Carnegie Instn. of Washington, No. 485)*, 1923. 10 x 6½ inches.

The first publication in the special research memoirs initiated by the National Geographic Society is an exhaustive statement of some anomalous features of volcanism presented by Mt. Katmai, Alaska, in its recent activity (1912). The actual eruption was not witnessed by any competent observer but undoubtedly had violently explosive early phases and covered the surrounding regions far and wide with a thin mantle of ash. The Valley of Ten Thousand Smokes, which extends some ten miles northwest from the base of the volcano, is also filled with pumiceous sand and ash of such a character and so distributed as to leave no doubt that the filling of the valley is a result of volcanic processes quite different from those which produced the far-flung ash mantle of the region. Fenner made an extensive examination of the field and, after a thorough study of collected material, has brought the general light of volcanology to bear on the problem. He concludes that the ash fill of the valley, enormous in volume, originated as a *nuée ardente*, or flow of hot ash, charged with a great volume of expanding gases. Flows and avalanches of this kind and the phenomenon of hot gas blasts are now well known. They generally originate from the crater, but at Katmai the field relations render such an origin most unlikely. Fenner provides evidence to show that the hot mixture of ash and gas was extruded from fissures extending from the neighborhood of the base of Katmai along the direction of the Valley of Ten Thousand Smokes.

The second paper deals also in the main with the Valley of Ten Thousand Smokes where the fumaroles are extensively developed. The authors made innumerable delicate measurements of fumarolic temperatures and collected many gas samples and incrustations. Topographic relations, surface water flow, and geological features were all carefully studied, and the materials collected have been submitted to refined

analysis. The results are an important contribution to quantitative volcanology. They show that many of the fumaroles are of deep-seated origin, though some may have originated in the ash flow. Fumarolic activity in the region is waning at an appreciable rate, with declining temperature. Some interesting special methods were developed during the research. The study of volcanic emanations, complicated at the outset by the difficulties of collecting truly representative gas, shows itself less and less reducible to simple statement as work advances. The authors hence exhibit the greatest caution in the interpretation of their results.

These publications are attractive in appearance and well illustrated with half-tone reproductions worthy of a better paper than that used. Each contains a map of the Katmai region in which the accentuation of the contours rather detracts from the important subject of the map. The pagination of the two numbers is continuous, and No. 1 has no synoptic guide to its contents.

Life on the Norwegian Coasts

Camille Vallaux. **Sur les Côtes de Norvège.** 189 pp.; map, ills. Librairie Hachette, Paris, 1923. 7½ x 5 inches.

One of the authors of "La géographie de l'histoire" takes a journey to Norway and sees so much on the way that he needs must write this little book about it, looking back now and then into history for the explanations of things and looking about him also with keen eyes at the life of the coastal people of Norway. The breadth and power of his observation suggest similar traits in the travel writings of the late Lord Bryce. There is much valuable information for the ordinary traveler without the style or substance becoming guidebookish in any degree. At the start there is an especially vivid and informing description of the differences between the outer and the inner waterways along the Norwegian coast. Instead of calling these complicated channels and narrow inlets *fiords* he distinguishes between the outer channels (whether broad or narrow) that are open at both ends and those that penetrate the land. The former are called *sunds*, the latter *fiords*. They are as unlike in physical characteristics as in life conditions. Strong tidal currents, relative openness to the sea, lack of communication from village to village except by sea—these are the predominating features. By contrast the water of the fiords is quiet. Village may communicate with village readily. It is only when communication is desired from fiord to fiord that the sea highway must be resorted to. Communication from point to point on the Norwegian coast has always been a problem from the earliest days down to the present. The northernmost point to which the railway reaches is a little more than latitude 64° N. This corresponds with southern Baffin Land or Dawson in the Canadian Yukon. It is the end of the great trunk line that connects Trondhjem Fiord with Christiania, the capital. The only other railway from the capital to the west coast is the line to Bergen, in latitude 60° 20′ N. Roads and telegraph lines have a greater extension, and private telephone lines are now widely extended. Their advantages are described especially for the Romsdal Fiord just under latitude 63° N.

While fishing engages a large part of the population of the whole coastal region, it becomes the exclusive occupation of the outer settlements in the *sunds*, and this is especially true at Romsdal in Nordland and Finmark; and in the case of the Lofoten Islands there is a migratory fishing population which comes from southern localities, even from Sweden and Denmark. The cold upland is uninhabitable and useless for all but about two months of the year. During the height of the summer season cattle are driven to the *fjelds*, or rocky upland pastures, and butter-making and cheese-making are at their height. A small difference in elevation makes an immense difference in the degree of cold. On the south, in the Jostedal region, latitude 61° +, the permanent ice ends at 1200–1300 meters (with much local variation). The pastures of

the upland extend to about 800 meters, but they decline toward the north, and at Hammerfest they are at 60 meters. Above these levels arctic conditions prevail.

The author's explanation of the fiorded coast of Norway raises dissent. After describing the work of the present glaciers and the abundant and varied signs of their activity, he comments on the recency of glacial action and concludes that the scale of the features excludes glacial action as the chief agent in developing these great depressions 1000 to 1500 meters deep from the top of the *fjeld* to the bottom of the fiords. He believes that the principal lines of the relief are due to crustal disturbance. This is to say both too little and too much. No one will deny that the great outlines of the relief are due to crustal warping and breaking. But the evidence of ice as the predominating agent in molding the details of relief and even the fiords themselves is overwhelming. We mention only a few of the elements in the argument: the normal ground plan of the drainage ways of the coast, the extraordinary similarity of the topographic features to those in alpine regions where glaciers are known to have been the chief agents in producing the present relief, the carving of these features in a region where glaciers are known to have existed and their absence in places where glaciers have never acted.

A Historical Study in Baltic Trade

H. K. von Borries. **Die Handels- und Schiffahrtsbeziehungen zwischen Lübeck und Finnland. Ein Beitrag zur Geschichte der Ostseewirtschaft.** xix and 214 pp.; bibliogr. *Probleme der Weltwirtschaft 36.* Gustav Fischer, Jena, 1923. $1.20. 9½ x 6½ inches.

The favorable location of Lübeck as a trading center is shown in its changing aspects, beginning with the days of the Hanseatic League and following through the centuries to the present. The above work traces not only the development of the trade of Lübeck with Finland but also her entire trade relations in the Baltic Sea regions. It points to the prowess of Lübeck's traders during the stormiest as well as most fortunate days of the Hanseatic League through its fall, through the subsequent rise and fall of Swedish mercantilism, to the founding of the German Empire and the beginnings of the World War.

The rise of Stettin and Hamburg, with their respective advantageous hinterlands and consequent handicap to Lübeck, is brought out. Lübeck's leadership in the Baltic trade in spite of competition with Danzig, whose development has in many respects paralleled that of Lübeck's is discussed in some detail. Attention is given to Lübeck's weakening position as a European trade center because of the rivalry with other near-by centers such as those mentioned above and because of the shifting world trade routes.

Lübeck's first contact with Finnish merchants occurred at the two opposite ends of the Gulf of Finland, namely Åbo in the west and Viborg in the east. The castles, fortifications, and museum collections of these towns stand as mute evidence of the once commanding position they enjoyed. Although they do not possess the importance today which was theirs in a smaller commercial world, it is significant that they still play an important rôle in the Baltic.

Although Finland has had a rather variable political career, its fortunes cast alternately with eastern and western culture, its people have retained a unity that is rather unique. The internal structure of the country has never been really seriously disturbed, at least never for a protracted period. Consequently the study of its continuous trade with a port like Lübeck offers opportunity for weighing the influences of external factors, as opposed to internal factors, upon the trade of a country. Geographic factors, political changes, tariff adjustments, and wars are all given consideration in their varying influences upon the trade relations between Lübeck and Finland. The work is well arranged, indicating careful research, and deserves a warm welcome

as a contribution to much needed scientific and intensive studies of trade development in various parts of the world.

There is a statistical appendix covering the trade, both in quantity and value, between Lübeck and Finland. The data are complete up to 1913. Another portion of the appendix includes data relative to the number of ships which have been engaged in the trade between Lübeck and certain specified ports of Finland from the earliest times to the present. The tables indicate the arrivals and departures of ships by ports for successive years. For the period since steam power was introduced the data are classified as to character of motive power. An excellent bibliography accompanies the publication.

EUGENE VAN CLEEF

BALKAN CLIMATOLOGY

VIKTOR CONRAD. **Beiträge zu einer Klimatographie der Balkanländer.** *Sitzungsber. Akad. der Wiss. in Wien, Mathem.-Naturw. Klasse*, Vol. 130, 1921, pp. 425-467.

In 1916 Conrad published a report on the climatology of Serbia (*Sitzungsber. Akad. der Wiss. in Wien, Mathem.-Naturw. Klasse*, Vol. 125, p. 1377). The present study deals chiefly with Albania and Montenegro and is really the outgrowth of the meteorological organization established for military purposes during the late war. In addition to the data secured at the stations which functioned during war time, there were also available observations from other regular climatological stations. The war stations were actually in operation from June, 1917, to September, 1918, only; but their data served for purposes of comparison and of broad generalization and were deemed worth discussion in view of the great lack of more reliable information from the area and of the certainty that a long time must elapse before any regular meteorological service can be established there. Exact values of the climatic elements are not yet to be expected. Every effort has been made to eliminate errors; and, when possible, reductions to the same period were carried out. Considering the scarcity of observations and the difficulties of analyzing and of comparing the data, the author has really done a remarkably good piece of work.

Extraordinary contrasts of temperature between the warm waters of the sea and the cold mountains adjacent to the coast are found in winter in the vicinity of the Bocche di Cattaro where the isotherms are so closely crowded that they can be drawn only with great difficulty even on a large-scale map. It is from these cold inland plateaus that the well-known bora of the eastern shores of the Adriatic blows in winter. During the colder months the deep valleys and lowlands are filled with very cold and stagnant air, a marked climatic characteristic of this rugged Balkan topography. The Albanian summer is described as being "unbearable" for natives of central Europe. This fact is ascribed to the frequency of high temperatures at night and in the mornings and to a monotony of the heat.

Remarkable contrasts in rainfall are noted. Cetinje has an annual mean of nearly 140 inches. This large amount is due to the forced ascent of the onshore winds over the high mountain barrier. Back from the coast the amounts are very much smaller. Here, as in the case of the temperature, topography is a very critical control. Great variability in monthly and annual rainfalls is characteristic of the whole area. In summer Albania has severe droughts. The cold-season thunderstorms of the Albanian coast are interesting phenomena. They apparently result from the movement of colder air from the land underneath the warm and damp air which lies over the coast and the adjacent waters. Snowfall records are few, short, and unreliable. According to report, deep and enduring snow cover is of regular occurrence in the eastern wooded parts of Montenegro. In common with other "Mediterranean" climates, Albania has unusually cloudless summers. The mean for a number of stations is less than 2/10. During its dry and sunny summer months Albanian vegetation dries up, while

the cloud-burst type of rainfall in autumn and winter washes away the soil on the slopes. Abundant vegetation is found only where there is sufficient water and where there is protection against the wind.

Dr. Conrad's discussion, dealing with an area climatically but little known, fills a gap in the literature of European climatography. It has the characteristics of most studies of its kind in that it presents the available facts systematically, clearly, and in standard form. But it lacks vitality. It is not interesting. It gives no descriptions of weather types. It contains only a casual reference or two to human or economic responses.

R. DeC. WARD

AN ADMINISTRATOR IN NEW GUINEA

C. A. W. MONCKTON. **Some Experiences of a New Guinea Resident Magistrate.** x and 337 pp.; map, ills., index. John Lane, London; John Lane Co., New York, 1921. 9 x 6 inches. (Also published under the title "Taming New Guinea," Dodd, Mead & Co., New York.)

C. A. W. MONCKTON. **Last Days in New Guinea.** x and 287 pp.; maps, ills., index. Dodd, Mead & Co., New York, 1922. 9 x 6 inches.

The state of aboriginal society in Melanesia depends upon the relations of three powerful sets of interest—those of the missions, of the commercial development, and of the administration. The last is the regulating force, and Mr. Monckton's books are a splendid account of its methods in New Guinea prior to 1907. The first book is a narrative of roving life from 1895 to 1897 and of official work from 1897 presumably to 1903. The second carries the narrative to the end of the author's official career in 1907. Forcibly written, evidently very much as he would speak, Mr. Monckton's narratives provide a great deal of information gathered from personal experience in the districts under his command. Topographical descriptions, distribution of tribes, customs, and languages, accounts of weather, and the treacheries of coral seas, with their sudden shoals and tide rips and "gubas" (rain squalls), are simply recorded with no sign of an effort to be technical. Unfortunately the author has paid little attention to chronology, and, although events are doubtless dealt with in the order of their happening, it is difficult to place an occurrence in its precise period. But whatever be the faults of narrative presentation, Mr. Monckton convinces one of his authority. The work is honest, and New Guinea should benefit from his experience and criticism.

We gather a strong impression from an analysis of the narrative that, during the time of Mr. Monckton's experience, part of the southeast peninsula of Papua was in that phase of active colonization by native races which must precede stable settlement by groups of tribes strong enough to maintain ownership of their territories. In the region between the northeast coast and the Didina and Hydrographer's Ranges, for example, branches of the Binandere people were pushing southeast along the plateau-like eastern apron of the ranges The apron behind the Musa River and Collingwood Bay was in possession of the Doriri people. In the ranges to the west were utterly foreign hillmen (refugees?) occupying strong-point villages on the hilltops. To the east of the apron is a belt of grassland (partly uninhabited) and of sago swamps. East of this, along the coastal strips, were the small tribes, or grouped remnants of tribes, pushed outwards and hemmed in on all sides by misfortune. Unfriendly to one another, raided by sea and land, they readily welcomed the administration after recovering from the first mistrust. The whole relation suggests a colonizing movement along the apron (connected perhaps with drought and food shortage) by strong folk, who pushed the refugees aside to the coasts and mountains. The Agaiambu (the famous but erroneously-called "web-footed" people) seem to have been an extreme product of refuge. Before recollection, their tradition accounts them as refugees in the

morass and lagoons which receive the flood waters of the Musa. Here they developed an amphibious way of life which had a profound effect on their anatomical structure. Swept by an epidemic about 1870, they were reduced to about 40 in number in 1902 and are now extinct.

Monckton provides information which will contribute to the tectonic study of the D'Entrecasteaux and Louisiade groups and of Woodlark and the Trobriand group. His description of the small island of Iwa strongly recalls Hobbs's account of Chogach in the lagoon of Ponape, Caroline Islands, in its relation to aboriginal society (W. H. Hobbs: Cruises Along By-ways of the Pacific, Boston, 1923, pp. 37–38).

The later volume deals with the administration of the Northern as well as the North-Eastern Division and contains graphic accounts of the expedition to Mt. Albert Edward (13,000 feet) in 1906; and of an important traverse from coast to coast, via the Waria River, in what was then German territory, across the main range (11,000 feet), and down to the Gulf of Papua via the Lakekamu River, in 1907.

Notes on the puzzling archeology of the northeast hint at a very early occupation of Papua by an extinct people. The population of British New Guinea has been estimated at about one million. Monckton thinks that this is a considerable understatement. His evidence shows that even the highest mountains are occupied by a numerous and interesting hill folk, some of them being seminomadic.

The Strategic Focus of the Pacific

N. Golovin and A. D. Bubnov. **The Problem of the Pacific in the Twentieth Century.** Translated by C. Nabokoff. 256 pp.; maps, bibliogr. Charles Scribner's Sons, New York, 1922. $3.50. 8½ x 5½ inches.

The Powers of the Pacific are the United States and Japan. The authors have been greatly impressed by Mendeleiev's analysis of the Russian Census of 1907 (a work unknown in English) and argue that Japan has a serious population problem. Ethnic and environmental influences restrict the possibilities for successful Japanese expansion to certain climatic regions.

The United States stands seriously in the way of necessary expansion, in Hawaii, California, and the Philippines. The problem of the Pacific is therefore the solution of this difficulty between the United States and Japan. The authors regard it as an insoluble problem.

The efforts of Japan to secure an adequate base of supplies, especially of coal and iron, on the Asiatic mainland are analyzed, one might say exposed, with great directness. It is shown that Japan has entrenched a position which she could maintain as long as Russia stays in abeyance as an Asiatic power. Moral considerations compel the United States to adhere to the policy of occupation in the Philippines. The situation being thus, the authors do not waste time in predicting war but plunge into the strategic analysis of a naval campaign in the likeliest theater—the seas between southern Japan, China, and the northern Philippines. The overwhelming superiority and security of Japanese bases and the inadequacy of those of the United States, even were foreign bases open for use, seem to be evident. Apart from insuperable difficulties of transport to the distant theater, the United States navy seems to be at a disadvantage when compared with the Japanese, on the scores of tactical organization and composition of the fleets, speed of battleships, their armament, and the fact that the United States lacks battle cruisers. The comparison is based on the present condition and that on completion of the building program allowed by the Washington Conference. The outlook for the United States, in a last resort of conflict, is dubious.

The argument is well knit and sounds like a weighed utterance of opinion from able authority. It sets the mind working in an uncomfortable way. As a piece of writing alone, the book is gripping. It is like a course in naval strategic geography delivered by a teacher who compels admiration.

The Geography of Eratosthenes

A. Thalamas. **Étude bibliographique de la géographie d'Ératosthène.** 190 pp. Marcel Rivière & Cie., Paris, 1921. 10 x 6½ inches.

A. Thalamas. **La géographie d'Ératosthène.** 256 pp.; diagrs. Marcel Rivière & Cie., Paris, 1921. 10 x 6½ inches.

Eratosthenes was the greatest geographer of antiquity if depth and diversity of scholarship, originality of creative thought and keenness of critical spirit are true criteria. Born probably in 273 B. C. at Cyrene, then one of the leading intellectual centers of the Hellenistic world, Eratosthenes dwelt for a time in Athens and was called about 235 B. C. to Alexandria, perhaps to aid in the reorganization and cataloguing of the great library of which he became chief librarian some ten years later. At his disposal was not only the literature of what was by far the largest collection of books ever assembled prior to modern times but also the fresh geographical information gathered by the official surveyors and by the diplomatic, military, and administrative agents of a highly centralized and well-organized state.

Unfortunately Eratosthenes' writings have not come down to us intact. We know of them only in a multitude of fragments scattered far and wide through the works of later writers. Some of these fragments—for example the famous passage in Cleomedes' *De motu corporum caelestium* which describes Eratosthenes' method of measuring an arc of meridian—seem to represent with fair accuracy the thought and words of the Alexandrian scientist. Others are sadly garbled even at best. Indeed, there are some passages ascribed by ancient authors to Eratosthenes which cannot possibly have come from his pen. There are also numerous cases of apparent plagiarism where the Eratosthenic style seems to indicate the true source but where no acknowledgment of this source is given. Eratosthenes' geography, therefore, presents many thorny problems, which students have been trying to solve ever since the Renaissance.

In the two books under review M. Thalamas has set himself the somewhat Herculean task of clearing away the academic dross that in the course of centuries has accumulated around the interpretation of the work of Eratosthenes and also the more congenial one of explaining as clearly and reasonably as possible what is actually known about the geographer of Alexandria and what may justifiably be accepted on inference. M. Thalamas certainly makes no claim toward having settled definitely all the controversial points, and many of these will never be settled. We feel, however, that he has succeeded in his primary purpose; that of presenting a balanced estimate of the great librarian's contribution to the history of science.

The "Étude bibliographique" is devoted to philological matters. After relating the "history of the constitution of the text of the geography of Eratosthenes" M. Thalamas proceeds to a detailed examination of the text itself. He comes to the conclusion that the fragments are derived from two separate treatises, one primarily mathematical and entitled in all probability "The Exact Measurement of the Earth" and the other a geographical description of the inhabited earth entitled "Geographical Memoirs."

In "La géographie d'Ératosthène" M. Thalamas discusses the circumstances of Eratosthenes' life and surroundings and the material contribution of each of his two treatises to the geographical science of antiquity as a whole.

The work of Eratosthenes appears to have been characterized by a touch of individual genius, a combination of creative originality with critical acumen. Creative originality is nowhere better revealed than in his crowning achievement, the measurement of the circumference of the earth, of which M. Thalamas gives a thorough analysis. Besides being the first to attempt the measurement of the globe's circumference, Eratosthenes was the first to try to determine quantitatively how far the globe diverges from the form of a perfect sphere as a result of irregularities of its surface:

mountains and sea-filled depressions. Though earlier astronomers had associated terrestrial with celestial zones, Eratosthenes was the first to give "a genuinely scientific form" to the conception of terrestrial zones "by determining exactly on the sphere the position of the fixed circles which mark the limit of each." Likewise he was the first to describe in detail the physical features characteristic of the various zones and the first to invent a wind rose correlated with the direction of the axis of the globe and not merely with local positions.

Eratosthenes' critical acumen is everywhere apparent but nowhere more strikingly than in his rejection of Homer as an authority on matters of geography. He was unwilling to accept assertions merely because they had the weight of tradition behind them, and he sharply attacked the devotees of Homer. In passing judgment on the relative value of different kinds of information gathered for the compilation of his geographical description of the earth and for the construction of the map which he undoubtedly made, Eratosthenes' method seems alive with the critical spirit of modern science.

The Problem of Human Races

R. B. Dixon. **The Racial History of Man.** xvi and 583 pp.; maps, ills., bibliogr., index. Charles Scribner's Sons, New York and London, 1923. $6.00. 9 x 6 inches.

The study of human races began its advance towards scientific value rather late, and its progress has been much hampered by inheritances from the older studies of philology and politics, features valuable in those studies, it may be, but not of a nature to be applied without great care and reserve in race study. Those inheritances were very obvious in the works of the late Dr. Keane, and there has been for some years a desire to try to make a fresh start. Dixon has earned the praise of his fellow workers by his courage in setting together the results of his wide and careful reading in a new and individual way, even though his fellow workers may not be able to travel far with him and may regret that his book does not take account of some other work of a fresh character such as the London Medical Research Council Papers by Leonard Hill, the later papers of Giuffrida-Ruggeri and Biasutti and especially their books (V. Giuffrida-Ruggeri: Su l'origine dell' uomo, 1921; Renato Biasutti: Studi di antropogeografia generale, 1912), and, one might add, the overbold yet in parts suggestive essay of Griffith Taylor published in this *Review* in 1921 (*Geogr. Rev.* Vol. 11, pp. 54–119).

The problem of human races is admittedly a most difficult one, as most human stocks are fertile *inter se* and as also controlled breeding is obviously out of the question as a line of research. How may we think of the development of human diversities? The biological thinker will turn his attention to Darwin's "Variation of Plants and Animals under Domestication" and will see that with the growth of human influence the conditions under which the later phases of ontogeny (individual development) occur have been markedly altered. Now it seems reasonably demonstrated that, in these later phases of ontogeny, a good deal has to be credited to the influence of stimuli from the environment. If, then, these are permanently modified, as by the prolongation of the supply of soft food in infancy following the domestication of plants and animals, the course of development may be altered. In the first place, some character erstwhile important may diminish and even disappear. In the second place, the balance of development may be altered; and this may well give rise to new features in many ways, just as, in social anthropology, the conjunction of inheritances and their modifying influences on one another may not merely inhibit one another but may also lead to the emergence of quite new features (see W. H. R. Rivers: The History of Melanesian Society, 2 vols., Cambridge, 1914). Thinking on these lines we approach a dynamic conception of the slow mutability of human character, fairly

closely, if withal very complexly, related to environmental influences. The diversities of man thus seem to be brought under the general scheme of "Variation of Plants and Animals under Domestication," as Giuffrida-Ruggeri suggested, but they are on the other hand less subject to alteration than Boas has claimed from his studies on changes in bodily form of descendants of immigrants into the United States of America on grounds of elaborate statistics somewhat inadequately analyzed. That thought concerning human diversity is leading anthropologists towards a geographic outlook is an important consideration for geographers, who have long claimed that their duty is to study relations between men and their environments and who thus find the newer point of view in race study right at the center of their sphere of thought; it is obvious that the relations of environment to man's physique and to his individual development are of the very first geographic importance. Geographers who neglect them may go far astray in their studies.

Another biological thought which is almost as fundamental for race study as the above is that of the principles of inheritance. Here it has been shown of late years that we reach the best view available at present if we think of characters inherited usually from one or other parent; i. e. if we think of each human being as a mosaic of his ancestors. This is one of the first principles of Mendelism, and we should be warned therefore against emphasizing "pure stocks" among men. It is, indeed, probable that it will be found more scientific to study race characters rather than races, though those characters are often tied together in bundles. In a sense Dixon's book is a welcome experiment in this direction even if he emphasizes the bundle rather too much for the taste of some. Taylor's 1921 paper in this *Review* was another courageous attempt, weakened by its excessive sweep of generalization, and it had one feature which unfortunately Dixon's book rather lacks. The study of human diversity misses a great deal if it omits a survey of human skin; for it is through our skin that we come into relation with environment, and skin characters are a guide to hair characters and to metabolism and thus to many other aspects of race study as well.

If it be fair to say that the alterations of relations between men and environments have influenced human diversities, largely through modifications in ontogeny, then it becomes important to think archeologically as well as biologically. One of the aims of archeology is to trace out the evolution, in time, of man's relations with environment; and the evidences of changes in this respect in the Aurignacean and Tardenoisian stages of culture show that they probably exercised a considerable influence upon human structure, e. g. of the skull (see H. J. Fleure: The Races of England and Wales, London, 1923, and *idem:* Some Early Neanthropic Types in Europe and Their Modern Representatives, *Journ. Royal Anthropol. Inst.*, Vol. 50, 1920, pp. 12–40). Dixon has hardly taken sufficient account either of the biologist's thought or of archeological work in his synthesis, which will best meet the proper meed of appreciation if it be looked upon as an attempt to study statistical data and to generalize from them. This, however, need not prevent racialists from deriving a good deal of profit from Dixon's review of statistical data, much as one regrets the omission of Czekanowski's paper on Poland (*Bull. Soc. Anthropol.*, Paris, 1920) and of Giuffrida-Ruggeri's statistical paper on Asia (English transl., "The First Outline of a Systematic Anthropology of Asia," Univ. of Calcutta, 1921) from the bibliography. Dixon chooses three characters of admitted value—cephalic index (b/l), altitudinal index of the skull (h/b), and nasal index. Using these he works out a set of distinctive combinations. Dolichocephaly (D), Mesocephaly (M), Brachycephaly (B), Hypsicephaly (H), Orthocephaly (O), Chamaecephaly (C), Leptorhiny (L), Mesorhiny (M), Platyrhiny (P) are the classes he uses. He emphasizes the extremes and suggests sight combinations of them, to which he gives names, viz.: DHP Proto-negroid, DCP Proto-australoid, DHL Caspian, DCL Mediterranean, BHP Palae-alpine, BCP Mongoloid, HBL Alpine, BCL Ural. Whatever may be thought of the names, there is certainly some value in the discrimination of these groups, but the omission of the middle terms

inevitably suggests that they result from intermixture of the extremes, a view which is perhaps only of limited applicability. Moreover, the classes sketched above are based upon averages and need careful handling if error is to be avoided. For example, in a DCL population in the Mediterranean region there is likely to be a DHL element due to survivals of early Neanthropic types, and between them and the ordinary Mediterranean the gradations are fairly fine. It would seem valuable to picture a DHM group evolving towards DHL and DCL in different regions under differing influences, and it is this process of evolution that is rather obscured by Dixon's method of treatment. His names are taken to be morphological labels, not geographical ones in the first instance; and so when he speaks of "Mediterranean" in America we must not imagine that he has hare-brained views about migration. He would probably state that morphological similarities in all three points imply some measure of homology, and with that none need quarrel. Both Taylor from his point of view and the writer of this review from a rather different one have urged that we may have true homology even between characters of men in regions so remote from one another as America, Australia, and Europe. Whether geographical names are the best ones for what are morphological types is another matter, and here it is difficult to follow Dixon. One cannot but welcome, however, at least one of his new names—that of "Caspian," which is a useful substitute for the overworked name of Nordic or proto-Nordic. The latter name might be restricted with advantage to the fully evolved tall, longheaded, fairly high-headed, narrow-nosed blond of northwestern Europe, etc. Dixon is inclined to see in changes of regional type evidence of decline of one stock and spread of another; but he might make his view far more valuable did he but suggest that, for example, brachycephaly in Europe seems to behave as a sort of Mendelian dominant, so that it has spread remarkably there. This does not imply that the sociological considerations the author brings forward are not of importance as well. It is a very good feature that Dixon always keeps clear of the error involved in the idea of "One region, one type."

Summing up, one must say that neither in biology nor in archeology is the book fully satisfactory; it does not sufficiently give us a picture of human nature in process of becoming. But its survey continent by continent is well done, with a few unfortunate omissions, and provides stimulating reading and food for thought. There are here many valuable bricks which may later on be used by Dixon or other architects for a more weather-proof building.

H. J. FLEURE

THE ABRIDGED EDITION OF FRAZER'S GOLDEN BOUGH

J. G. FRAZER. **The Golden Bough: A Study in Magic and Religion.** Abridged edit. xiv and 752 pp.; ill., index. The Macmillan Co., New York, 1922. 9 x 6 inches.

Sir J. G. Frazer's life work has been so remarkable as to be a romance. He set out more than thirty years ago to solve the problem of the succession to the priesthood of Diana at Aricia. His reading spread ever more widely, and the original two-volume work grew into 12 volumes, while numerous and important volumes appeared outside the main series. The work of the author has in fact produced a mine wherein expert quarrymen may find treasure on all sorts of subjects connected with the earlier phases of civilizations and their survivals. No corner of the world about which there are books seems to have escaped his attention, and his thought ranges over many subjects which have bewildered readers anxious to follow the main trail. The student will therefore be grateful for this abridgment which keeps the arguments and conclusions and often the phrases of the original but tries to help us to see the wood in spite of the infinite multitude of interesting trees. The abridgment omits many footnotes and the references, but it keeps the literary beauty of the original and, in effect, presents the reader with a clearer argument.

The King of the Wood obtained his priesthood of Diana at Aricia by killing his predecessor, and he in turn was subject to being challenged to mortal combat by any one who attempted to pluck the golden bough. The elucidation of this custom led Frazer into the study of king priests and so into forms of magic, doctrines of incarnation, ideas of taboo, the perils of the soul, the killing of the divine person and analogous sacrifices, the eating of the god, evil and the scapegoat, fire festivals, Balder and the mistletoe, and so on almost ad infinitum.

The student of geography may well read and reread Frazer if he be inclined to overemphasize influences of environment, for the multitudinous references bring out endless similarities that not even the most courageous of us could ascribe to migrations of culture. At the same time the environment plays its part everywhere and induces local modifications which tell their tale provided we are careful to sort them out from cases of what may be called evolutionary or historical differences.

H. J. Fleure

Climatic Belts and the Development of Civilization

Siegfried Passarge. **Landschaft und Kulturentwicklung in unseren Klimabreiten.** 165 pp.; maps, bibliogr., index. L. Friederichsen & Co., Hamburg, 1922. 10 x 7 inches.

Siegfried Passarge. **Die Landschaftsgürtel der Erde: Natur und Kultur.** 144 pp.; map, ills., index. (Jedermanns Bücherei.) Ferdinand Hirt, Breslau, 1923. 7½ x 5 inches.

Whatever one's personal convictions may be relative to environmental influences upon the development of civilization, a reading of these two books must surely prove a stimulant to one's thinking along these lines. The two publications might have appeared as a single volume with a re-orientation of content: since they dovetail, their subject matter may be readily reviewed as a unit.

Passarge divides the earth for convenience of treatment into five climatic belts as expressed by the distinguishing plant associations. The belts are the two "polar caps with cold summers and winters, the two middle belts with warm summers and cold winters, and the hot belt with warm winters and hot summers." These are then subdivided. It seems a mistake, certainly, to speak of climatic "belts" or zones about the earth, when topographic differences and the irregular distribution of land and water preclude a belted arrangement of either climate or vegetation. The author admits a certain weakness in his scheme but seems to feel it justified in view of the absence of any perfect classification. In the second-named volume he delineates the belts, but in the map accompanying the first book his belts are so broken up by the subdivisions as to show that belts in reality do not exist.

Upon a closer examination of the maps it is difficult to appreciate the classification in all instances—for example the inclusion of the Puget Sound district and the northern half of the Great Lakes region, beginning at the western end of Lake Superior and continuing to Massachusetts Bay and Long Island Sound, as "Subtropisch-gemässigte Waldländer;" or the southeastern portion of the United States (excepting the southern extremity of Florida), extending from Galveston to the western end of Lake Erie and thence eastward to Long Island Sound, as "Subtropische Regenwaldländer."

However, these matters do not seriously impair the conclusions which the author aims to impress upon the reader. His purpose is to show the extent to which natural and man-made factors have operated in the development of our social progress and the processes which are now destroying modern civilization. In his "Landschaft und Kulturentwicklung," he points out that all peoples experience an early period of

internal development, a later golden era sometimes accompanied by an assertion of physical power, and an eventual decline. The cause of the decline may be attributed to circumstances inherent in the character of the people or to the effect of their environment. Passarge insists that the latter influence is decisive and then seeks to demonstrate the truth of his contention. He traces in a somewhat systematic manner the status of various groups of peoples in different stages of civilization, stating first the conditions of their indigenous culture, then the successes or failures of foreign influences consisting either of a civilization imposed by a conquering people or introduced by the slower methods of peaceful immigration, and finally the destructive effects of the climax modern culture which he terms "Maschinenkultur." This cultural stage he finds represented in the "middle" belt of the earth and best exemplified by the Germanic peoples.

Machine culture, or the mechanical age, has a degenerating effect upon the nervous system and tends to cause complete breakdown of the whole moral fiber. The reviewer can support this argument to the extent of citing the prevalence of neurasthenia among the Finns of New England who have come from the farms of Finland and now are engaged in factory labor. On the other hand there is no indication that the moral standards of the people have been so influenced as to have broken down their cultural attainments. Passarge is decidedly pessimistic and somewhat of an extremist in his views.

The last part of "Die Landschaftsgürtel der Erde" is given over to a discussion of city landscapes, and here again the author attempts to demonstrate how the transition from medievalism to modernism has been dominated by mechanical influences and how these effects have tended to disrupt civilization. He cites attractive Nürnberg with its medieval setting in opposition to the peripheral ugly new city. The unhygienic character of the narrow winding streets, the poorly lighted houses with badly ventilated rooms, and general crowding are freely admitted; but seemingly the consequent picturesqueness of the old city, its charm, and its appeal to the artistic temperament are to be preferred to the more healthful modern city of straight wide streets, barrack-like apartment houses, or American skyscrapers with their ant-like colonies of people pushing each other breathlessly in the chase for the dollar. Great modern cities represent the triumphs of trade in all its manifold aspects where the world's knowledge and technique are brought into closest working harmony. They also constitute the centers where people's souls are hopelessly poisoned and their very vitality is seriously impaired.

An appendix of thirty-one photographs of type landscapes, both country and city, accompanies the second publication, and a bibliography is appended to the first book.

EUGENE VAN CLEEF

OUTLINES OF CLIMATOLOGY OF THE CONTINENTS

W. R. ECKARDT. **Grundzüge einer Physioklimatologie der Festlander.** 123 pp.; maps, diagr., bibliogr., index. Gebrüder Borntraeger, Berlin, 1922. $1.10. 10 x 6½ inches.

To Dr. W. R. Eckardt we already owe several excellent contributions to climatological literature. "Das Klimaproblem der geologischen Vergangenheit und historischen Gegenwart" (1909) presented an important subject of great complexity in brief and systematic form. His "Paläoklimatologie" (1910) in the well-known Sammlung Göschen, still further condensed the material included in the earlier volume. And his "Klima und Leben" (1912), also in the Sammlung Göschen, brought a simple and very useful statement of the relations of climate and life from the point of view of a climatologist.

Dr. Eckardt's new publication is original in title as well as in the method of treatment of the subject. It deals with the climatology of the continents but contains not

a single table and hardly any numerical data. Its aim is to show how climate fundamentally depends upon the changes in seasonal pressure conditions. Pressures control winds and precipitation. Temperatures in their turn both result from the pressure distribution and also to a large extent control the pressures. There is thus an interlocking of causes and effects, the effects often reacting on the causes; but the key to the situation may be found in the distribution of pressure. Rainfall is the most critical single element in climate, and appreciation of a country's climate really centers in an understanding of rainfall causes and characteristics. The title of the volume before us is "Grundzüge," not "Die Grundzüge." It does not attempt to be exhaustive, but it certainly does give a vivid description of the climates of the continents from a viewpoint which is to a large extent new.

We ourselves have found the climatic outlines clear, vivid, and interesting. They are clear because well written and brief. They are vivid because proper emphasis is laid upon the seasonally varying weather types which make up the different climates. They are interesting because they have life and because the human and economic relations are constantly kept in view. Dr. Eckardt's little book should be on the shelf of every one who is concerned with climatology and who really wishes to get at the underlying controls of the climates of the world. This volume cannot, it need hardly be said, replace Hann's monumental "Handbuch," but it will serve as an excellent supplement to that absolutely indispensable work.

Of the 118 pages of text, 44 are devoted to Europe and only 10½ to North America. This inequality of treatment is probably excusable in the case of a German meteorologist, but it is a bit disappointing to an American. The Mediterranean area is given 15 pages and is admirably done.

R. DeC. WARD

GEOGRAPHICAL DISTRIBUTION AND ORIGIN OF SPECIES

J. C. WILLIS. **Age and Area: A Study in Geographical Distribution and Origin of Species.** With chapters by Hugo De Vries, H. B. Guppy, Mrs. E. M. Reid, and James Small. x and 259 pp.; maps, diagrs., bibliogr., index. The University Press, Cambridge, 1922. 14s. 9 x 6 inches.

Geographers are not much concerned with organic evolution; but the relation of plants, animals, and man to their environmental controls is a leading geographic problem. Willis was a student of natural selection thirty years ago and after ten years of observation decided to conduct an independent investigation of the subject. His viewpoint is largely that of the student of evolution, although his subject is almost equally geographic and ecologic. As a result of his studies he came to the conclusion that "plants spread very slowly, but at an average rate determined by the various causes acting upon them, so that age forms a measure of dispersal when one is dealing with allied and similar forms." We should at once recall that age is no more a cause of evolution than is natural selection, for both are negative influences. Age means, primarily, opportunities for overcoming limiting factors or controls.

After referring to the idea of single and multiple origin of species, the author states that most plants arise in moderate-sized areas and later enlarge them. The most common methods of dispersal of individual plants are by means of the wind, water, or by birds and other animals. These he calls "regular" methods. Many species are carried by "irregular" methods, such as hurricanes and floating logs, which ultimately are so general in their operation that one can safely predict a large part of the invaders upon a new area. Plants, he declares, have, as a rule, traveled only slowly and for short distances by the regular methods and in the long run also by the unusual or accidental methods. Even the most cosmopolitan genera of plants have little or no special mechanisms for dispersal. In other words, this means that they have practically solved the problem of dispersal.

A number of students have held the idea that the introduction by man of species from large continental areas to islands and into foreign countries permits them to make great progress in establishing themselves in exotic regions and in overcoming the native species on account of their assumed superiority in the struggle for existence. The prevalence of the idea has been due, largely, to the neglect of the facts which show that it is mainly the man-made conditions about his settlements that destroy the native organisms and make place for the foreign associates and that it is largely this fact that accounts for their apparent success. Cultivated fields, pasturing, the destruction of forests, and similar influences make way for the foreign "weeds," and there is no competitive superiority on the part of the "weeds" over the native plants. Furthermore, foreign plants do not, as a rule, successfully invade native forests and wild conditions. Yet, on the other hand, there are a few striking cases where introduced plants have made wonderfully rapid extensions in foreign parts. The author has done a good service in calling attention to the needs of a critical study of this problem. Much additional evidence on this subject is given in a recent book by G. N. Thomson on "The Naturalisation of Animals and Plants in New Zealand" (Cambridge University Press, 1922).

Willis thus summarizes his views: "The area occupied at any given time, in any given country, by any group of allied species at least ten in number, depends chiefly, so long as conditions remain reasonably constant, upon the ages of the species of that group in that country but may be enormously modified by the presence of barriers such as seas, rivers, mountains, changes of climate from one region to the next, or other ecological boundaries, and the like, also by the action of man, and by other causes."

The author asserts that in prediction he finds abundant proof of his theory. In 90 cases he has predicted and later confirmed his idea that groups of species which on the average have the widest range are the oldest species. Thus he maintains that the flora of New Zealand, by means of a land connection, dispersed its plants to adjacent islands, the flora of the New Zealand mainland being the oldest. The New Zealand species which have the widest range are thus inferred to be the oldest in New Zealand and to have the widest range upon the adjacent islands.

To the student of endemism, either plant or animal, as related to floral or faunal problems, the ideas of Willis will prove valuable and stimulating. The ecological aspect of the whole subject, however, is not thoroughly comprehended. The appreciation of arid regions in relation to endemism seems to be underestimated. Furthermore, one does not need to belong to either the natural-selection or the mutation school to dissent from what seems to be an overstatement of the importance of age and area.

With the assistance of zoölogists the author extends his generalization to various kinds of animals. In the case of certain animals as well as of certain plants we have historical records and much other evidence showing that the rate of dispersal is not only very unequal but may be very rapid. Students of ecology, with modern methods of approach, distinguish pioneer organisms invading new areas from the laggards which survive only in the later stages of succession. The very recognition of this succession shows that the progress of dispersal and the extension or range take place at unequal rates. This particular subject and its methods of thought seem rather foreign to the author. The rate of physical changes in environment ranges all the way from gradual to rapid; and this is true in general of changes in vegetation and in animals. These facts make Willis' sweeping generalizations seem too strong. Calvert has recently examined the American dragonfly fauna from the standpoint of Willis but is unable to agree with him in his conclusions. American students have given considerable attention to the centers of origin and dispersal of the flora and fauna, to which no reference is made by Willis.

It would be interesting to get the long-range view of a paleontologist on this prod-

lem of age and area. He is accustomed to noting the origin, expansion, and decline of organisms through the ages. He knows that there is a continuous rotation of old and declining types and of new and advancing ones. How does our present age fit into the general scheme? And how can the criteria of relative age be best summarized and formulated? A definite formulation would do much to clear up the treatment of these ideas.

The problem of age and area is a subject about which it is easy to fall into the error of reasoning in a circle. One can hardly doubt that age must have considerable influence. I have been unable, however, to escape the feeling that the author's conclusions go too far and appear to prove too much. The problem is not as simple as it seems, because the same result, wide dispersal, is probably accomplished by more than one rate and method, and the convergent results of diverse controls are frequently a source of error. The relative influence of each factor must be tested on its own merits. No one, however, can read the volume without recognizing that the book is a valuable contribution to biogeography and one that will prove stimulating reading to students in this field.

CHARLES C. ADAMS

THE TIDES AND THEIR UTILIZATION

E. FICHOT. **Les marées et leur utilisation industrielle.** vi and 254 pp.; diagrs., bibliogr. (Science et civilisation. Collection d'exposés synthétiques du savoir humain.) Gauthier-Villars & Cie., Paris, 1923. 7½ x 5½ inches.

Tides and tidal currents—the movements of the sea in response to the attractive forces of sun and moon—are oceanographic phenomena which have, very largely, been relegated to the mathematician. This is no doubt due to the success which has attended the labors of the mathematician in this field, but as a consequence this large province of oceanography has remained almost closed to all but the mathematician. Despite Krummel's emphasis that it was the needs of the geographer and not those of the mathematician that he had in mind, he nevertheless made use of no inconsiderable amount of mathematics in the discussion of tides and currents in his "Handbuch der Ozeanographie." It is freedom from formal mathematics that distinguishes the volume under review and makes it a noteworthy contribution in this field of oceanography. Himself a mathematician—M. Fichot is a chief hydrographic engineer in the French Hydrographic Service and is further known as the editor of the third volume of Poincaré's "Leçons de mécanique céleste," which is devoted to tidal theory—the author discusses the tides and related phenomena in non-mathematical language but at the same time retains the precision of speech of the mathematician.

The introductory chapter discusses the various aspects of tidal phenomena, follows with a brief historical review, and concludes with several paragraphs on relativity and the tides. The second chapter is devoted to a discussion of the tide-producing forces, and the three succeeding chapters deal respectively with the undulatory movements of the ocean, the formation and propagation of the tides, and the conquest of "blue coal."

The author emphasizes the importance of resonance in the making of the tide; hence he naturally pays considerable attention to the stationary-wave theory of the tides developed by the late R. A. Harris. After describing the oscillating systems into which Harris divided the oceans, he notes that one cannot fail to be struck by a certain arbitrariness in this. He finds, nevertheless, that, despite all criticism that can justly be brought to bear against these oscillating systems, the explanation which they afford of almost all the varied phenomena of the tides "confers upon them assuredly a high degree of probability." As distinguished from preceding theories, the stationary-wave theory "has, furthermore, the great advantage of furnishing a logical

explanation for the formation of the [tide] waves and one that conforms to the requirements of the dynamical theory of oscillations." He concludes with Poincaré that the definitive theory "will probably have to borrow from that of Harris a considerable part of its principal features."

Of interest is the author's suggestion as to a possible connection between Harris' theory and the Wegener hypothesis. "Every tide proclaims a conquering heavenly body beyond the clouds; can this heavenly body have left its impress in the relief of the seas that it animates?" If the continental frontiers of the oceanic basins are, or have been, mobile, M. Fichot thinks that, given a considerable break to begin with, the tides may have played a rôle in the further separation of the continents. The author's argument may be summarized somewhat as follows: The pressure of the tidal currents against the opposite sides of an oceanic basin would become nil only in the case that the period of oscillation of the basin were the same as that of the principal tide-producing forces. With drifting continental masses the tendency would therefore be toward the formation of oceans of such size as to constitute basins of resonance under the action of the tides.

The last chapter, under the heading of "the conquest of blue coal" discusses the general question of the utilization of tidal energy and the various systems proposed to overcome the disadvantages of the variability inherent in the rise and fall of the tide. The concluding portion of this chapter is devoted to a description of the plans outlined for the utilization of the energy of the tide in the estuary of the Aber Vrac'h, a stream flowing into the English Channel about 25 kilometers north of Brest.

The book is written in a clear and pleasing style; but, dealing with a difficult subject fundamentally, it cannot be said to make easy reading. It is in no sense a handbook for the tidal specialist, nor is it a manual for the student, being addressed to the intelligent layman. It should prove especially valuable to the geographer in acquainting him with the problems and progress in this field of oceanography. A six-page bibliography, which the author states to be incomplete and to be limited only to the publications used in the preparation of the volume, adds to its usefulness, since it lists a considerable number of the more important recent publications. The almost complete absence of illustrations—there are but five figures in all—detracts somewhat from the full value of the volume.

H. A. MARMER

THE PROBLEM OF POLAR WANDERING

L. A. COTTON. **Some Fundamental Problems of Diastrophism and Their Geological Corollaries with Special Reference to Polar Wanderings.** Bibliogr. *Amer. Journ. of Sci.*, No. 206, Ser. 5, Vol. 6, 1923, pp. 453–503.

A number of eminent astronomers have dealt with the possible displacement of the earth's pole. Under the assumption that the earth is perfectly rigid they found that geological processes would cause only an insignificant displacement; but if the earth is sufficiently plastic the pole might be materially displaced. The author examines the various phenomena which cast light on the earth's interior and concludes that it is sufficiently plastic to yield to forces acting for a long time in the same direction but has a high elasticity for periodic forces of short period—a conclusion which agrees with the views of most geophysicists. But the further conclusion that it is reasonable to suppose that the pole has wandered over considerable distances will meet with objections. It is quite evident, without investigation, that if you could sufficiently alter the distribution of matter in the earth, you could change the inertia pole to any extent; but what would produce such an alteration? It is easy to calculate, from the formulae that the author gives, that if the continent of North America stood everywhere two miles below sea level, and that then the material under it to a depth of

60 miles expanded uniformly so as to raise the surface two miles above sea level, the pole would be displaced less than two minutes of arc. It seems difficult to find in geological history movements sufficient to move the pole many degrees. Mr. Cotton thinks that "if the theory of polar wanderings be merely accepted as a working hypothesis no harm can be done." I would go further and say that it would do much good *if* it led investigators to a *thorough* study of the distribution of climates in the various geologic ages; for our knowledge of this subject is woefully unsatisfactory. Many eminent paleontologists do not believe that a change in the position of the pole would account for the distribution.

At the end of the paper is given a long and useful list of scientific papers dealing with the physical characteristics of the earth.

HARRY FIELDING REID

REGIONAL PETROLOGY AND THE DRIFTING OF CONTINENTS

H. S. WASHINGTON. **Comagmatic Regions and the Wegener Hypothesis.** *Journ. Washington Acad. of Sci.*, Vol. 13, 1923, pp. 339–347.

The Wegener hypothesis of continental disruption and drift is stimulating every branch of geological thought at the present time. Dr. Washington contributes here a preliminary criticism from an examination of the petrological bearing of the hypothesis. If the pieces in the "jig-saw puzzle" of Wegener's primitive parent continent can be made to fit together, the igneous rock mosaic should match on the opposite sides of the breaks. Comparison of the comagmatic regions (i. e. regions where the igneous rocks are broadly related) on opposite shores of the Atlantic, in latitudes corresponding to Wegener's piecing together of the European and African with the American land masses, shows only the vaguest correspondence in their igneous manifestations. A few examples may be quoted from Washington's paper. The rocks of Baffin Land show a general resemblance to those of the Canadian Shield and offer no example, as far as known, of the alkalic series occurring in Greenland; Greenland lacks the anorthosites found in Norway; the Labrador anorthosites have no counterpart in corresponding regions of Europe; the Triassic traps of the Middle Atlantic States and the rather uniform lime-soda granites of the Appalachians cannot be paralleled in Europe; the critical regions of the Brazilian elbow and the Gulf of Guinea show great dissimilarity in their igneous rocks. An apparent resemblance exists on the flanks of the South Atlantic but loses its appearance of probability on close examination. The hypothesis may be regarded as unsupported by the evidence of comagmatic regions.

As igneous rocks form the great bulk of the earth's crust, in spite of their relative paucity of outcrop on the earth's surface, Dr. Washington's application of test is a formidable obstacle for Wegener. The requirements of isostatic adjustment, by lateral transfer of material at a depth, have not been considered in the paper and seem to need examination. They may well have had some effect on the bulky outpouring of basic material *after* the period of Wegener's hypothetical break-up of the parent continent and may help to make the evidence of the plateau basalts of the North Atlantic and South America, as well as of the magnificent Stormberg series of South Africa, more decisive.

INSECT PLAGUES OF THE TROPICS

ÉMILE HEGH. **Les Termites.** 756 pp.; map, diagrs., ills., bibliogr. Imprimerie Industrielle & Financière (Société Anonyme), Brussels, 1922. 9½ x 6½ inches.

Three groups of insects have held the tropics against the commercial advance of the white race. The tsetse fly has prevented the use of cattle and horses and retarded the agricultural development of the country; the mosquito has made the

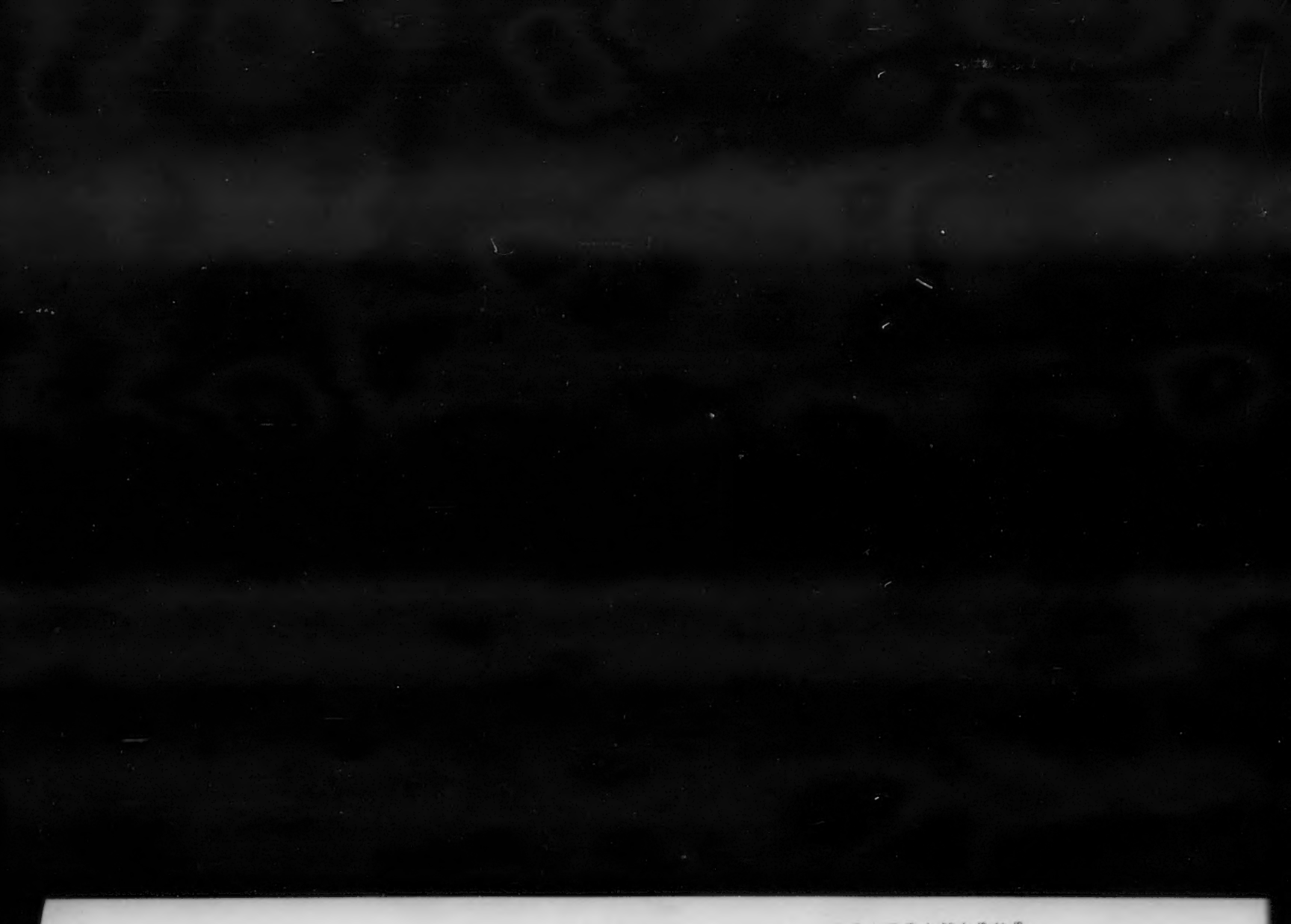
continuous life of the white man precarious by the spread of malarial and other fevers; and the white ant by destroying vegetable or animal substances has offered a barrier even harder to overcome.

The importance of the last, the termites, as a geographic factor can be fully appreciated only by those who have seen the work of these insects in tropical countries. While they are found in the temperate zones they do not there become the serious menace to material development that they do in the tropics. Hegh, in the first volume of a proposed two-volume work, has brought together a fund of information about this most important group of insects. A great part of the data is of a purely biological nature, but some should be known by the geographer if he is to evaluate rightly the place of the termite in the environment.

The temporary or permanent wooden structure which has played so great a part in the development of temperate regions cannot be used in the tropics: houses, furniture, stores, fences fall to a mass of dust when a few days before they appeared perfectly sound on the surface; many crops and trees cannot be grown because of the ravages of the insect. Some idea of the importance of the termites may be obtained from the fact that railroads through tropical forests cannot use wooden ties but must import iron or steel ties at great cost if the line is to be at all permanent.

The numerical importance of the termites may be based: (1) on the number of species; (2) the number of colonies or hills; and (3) the number of inhabitants in each colony. The species are numerous—more than 400 occurring in Africa alone. At times the hills almost completely cover the ground, although many of the nests are entirely subterranean and others are in dead trees or on live trees. The nests may be only a few centimeters high or in other cases enormous masses of argillaceous material ten to twelve meters high. In form they may be oval, columnar, pyramidal, or complicated almost beyond general description. In color they are usually that of the soil of which they are built. They contain galleries and chambers in dead wood or soil or are made of crusted particles of soil or wood or other vegetable matter. As individuals the termites are beyond number. They are most numerous in Central Africa, in Ceylon, Malaysia, and northern and central South America.

H. L. SHANTZ

E. E. AUSTEN AND ÉMILE HEGH. **Tsetse-Flies: Their Characteristics, Distribution and Bionomics, With Some Account of Possible Methods for Their Control.** With a Preface by the Earl Buxton. ix and 188 pp.; ills., bibliogr., index. The Imperial Bureau of Entomology, London, 1922. 7s. 6d. 9½ x 6 inches.

This report gathers together in condensed and nontechnical form the results of the extensive researches conducted into the habits and distribution of the tsetse flies since their agency in the transmission of sleeping sickness and nagana, the corresponding disease in animals, was established by the discoveries of Major-General Sir David Bruce (1895–1896). The objective is to enlist all possible support towards the solution of one of the most serious problems in the development of tropical Africa. Sleeping sickness has decimated the native population over large areas, reducing the labor available for agricultural and commercial enterprise; nagana entirely precludes stock raising over important sections. The magnitude of the problem is illustrated by the Earl Buxton in his preface to the report, where he states that probably one-half of Tanganyika Territory is infested by the flies and three-quarters of Northern Rhodesia and Sierra Leone.